POWER

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The Heroism of the Humble

GOLD braid is not an essential habiliment of heroism, and the engine and boiler room have many times been the setting for the supreme sacrifice since Jim Bludso held her nozzle "agin the bank."

In the recent hurricane in the West Indies the master of a freighter was washed overboard. The coal in the bunkers shifted, giving the vessel a heavy list.

All but one of the lifeboats was smashed. When this was picked up hours afterward, the twelve men in it said that the steamer had gone down, carrying with it the wireless operator and the engineers and firemen who refused to make any attempt to enter the lifeboat with them.

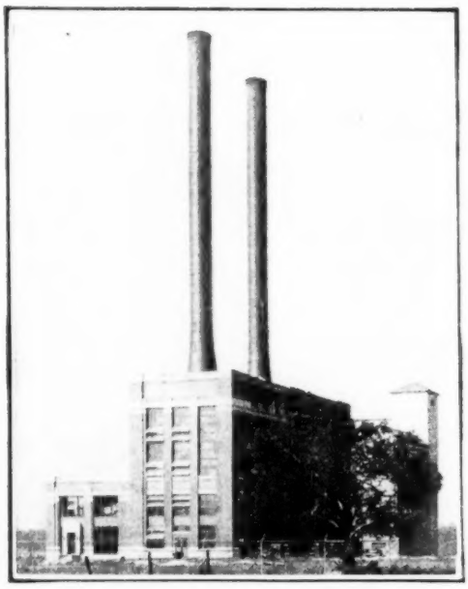
There are times and places and circumstances into which heroics naturally enter, and these are the kind that get into the books, the plays and the movies.

But real honor belongs to the man who keeps his head and his nerve and does the thing that must or should be done when the peril of death looms up in his ordinary walk of life.

Honor to the man who, on the possibility of saving other lives, swept aside the chance of taking to the boat with the rest and stood by his key, sending the message of their plight out into the boisterous air.

Honor to the engineers and firemen of the "Eastway," which went down off the coast of Bermuda while the twelve men in the only lifeboat looked on. The engineers and firemen took a fighting chance for their own lives that others might have a better chance for theirs. They lost, but the staff below decks adds another to its many unsung deeds of heroism and sacrifice.

F. R. Low



The Ford Canadian Power Plant

CO-ORDINATION of heating and power requirements, together with high-grade boiler-room equipment using pulverized coal, gives a plant of high economy. Attention to appearance and cleanliness produces worth-while results.

INTELLIGENT application of sound engineering principles characterizes the power plant of the Ford Motor Company of Canada, Ltd., at Ford City, Ontario, just across the river from Detroit. The factory demand for process steam and building heating is tied in with the power demand so as to minimize waste without sacrifice of operating convenience.

The location of the coal unloading bridge and storage yard some 700 ft. from the plant has made possible an appropriate setting for the attractive brick and stone building that houses the plant. Coal is carried to the plant by an underground belt conveyor. The use of pulverized coal having proved highly satisfactory in the Fordson plant on the River Rouge, it was natural to employ similar equipment in this plant.

Typical factory demands call for 6,000 kw. together with 20,000 lb. per hour of high-pressure steam for hammers and process work, and 26,000 lb. per hour at 5 lb. gage for heating water, etc. For building heating, the turbine exhaust steam furnishes heat through the medium of the condenser circulating water, which is pumped through a hot-water heating system. The turbine exhaust vacuum is varied in accordance with outside temperature changes.

Boilers and Combustion

The boiler room, rising 100 ft. above grade, houses the fuel-preparation plant, with evaporator and pump rooms in the basement.

At present the plant contains three boilers of the bent-tube type, each having 13,160 sq.ft. of steam-making surface, with space for a fourth unit of the same size. Each boiler is set singly. The operating pressure is 235 lb. gage and the superheat 200 deg. F. As shown in the sectional elevation, each boiler has four drums, with the central steam drum set higher than usual to get above the highest possible water level. An innovation is the use of a graded set of boiler tubes of three different diameters to obtain uniform heat transfer. In the first bank and in the first row of the second bank, where the gases are hottest, the tubes are 3½ in. in diameter; back of the baffle in the second bank the tube diameter is 3 in., and in the third bank, where the comparatively cool gases are leaving the boiler, 2½-in. tubes are used.

The rear tube bank is in effect an integral economizer, the feed water entering the top rear drum and passing downward through the rear bank of tubes into the lower drum. At the discharge end of the tubes are seal boxes, 22 in all, each box covering two rows of tubes, with specially designed nozzles that curve around the bottom of the drum and point into the tubes of the first bank. In addition to directing the incoming water into the front tubes, this arrangement obviates any tendency toward upward circulation in the rear bank.

With no steam-driven auxiliaries except a reserve boiler feed pump, the usual feed-water heater is eliminated and the returns enter the rear drum at a temperature approximating 125 deg. F. This gives the rear tube bank, or the economizer, as it may be called, a wider range than usual and a greater opportunity to absorb heat from the flue gases. An indication of this is the stack temperature of 480 deg. F. when the boiler is operating at 200 per cent of rating.

Another feature of interest is the method of connecting the water screen across the bottom of the furnace into the water circulation of the boiler. The screen consists of eight pairs of 4-in. tubes on 13-in. centers. The inflow into each pair is from a drum connected by drop pipes from the lower drum of the boiler and in reality serving as the main mud drum. From a U-fitting at the front of the setting the return pipe of each pair passes through the rear wall of the setting above the mud drum and rises into the lower drum of the boiler. The return pipes are rolled into the boiler drum, and loose-fitting tubes continue through the drum into the last row of tubes in the front bank to direct the circulation.

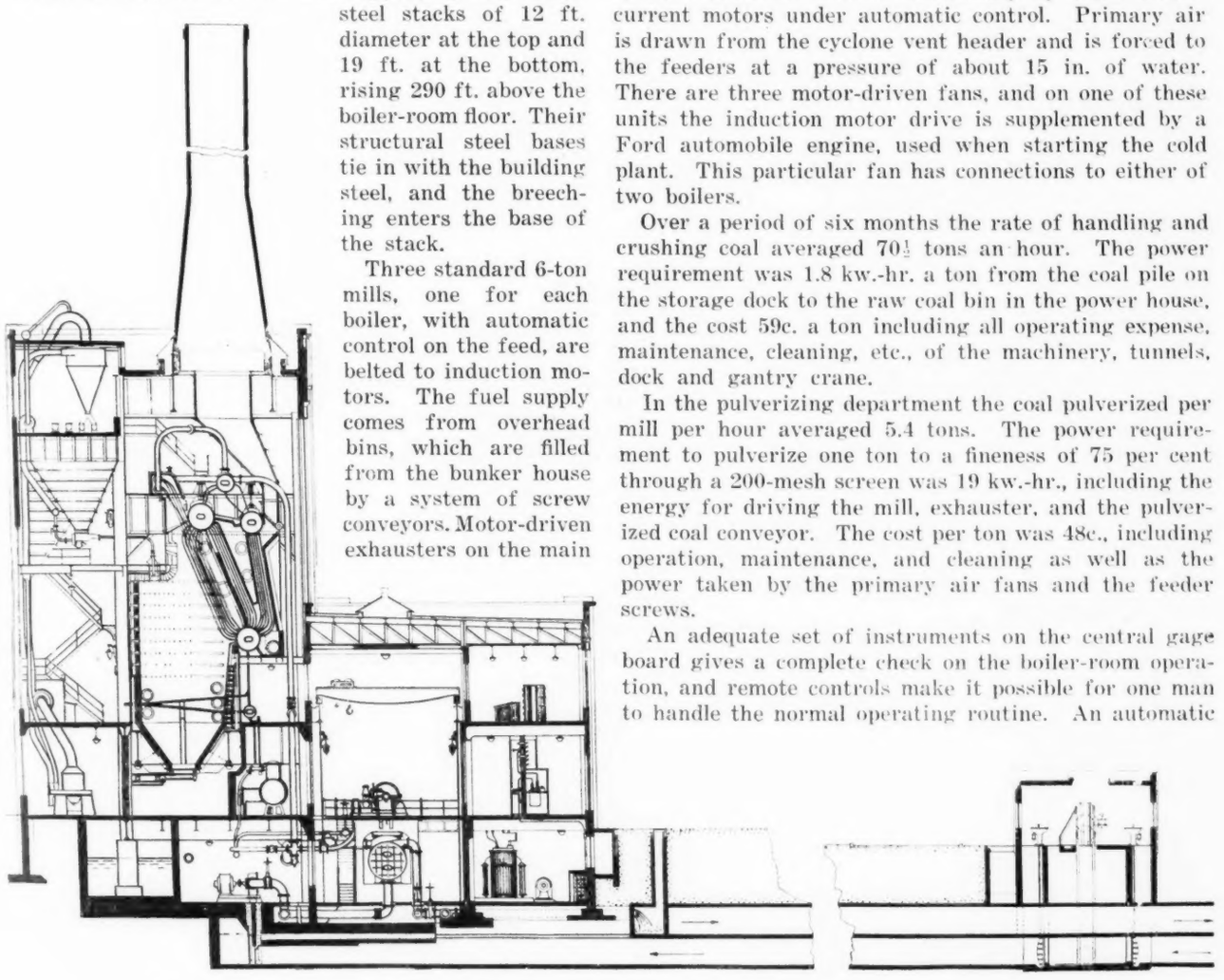
A superheater of the external header, hairpin type, is fitted between the tubes in the first pass, the tubes being located to break up the gas flow and insure uniform distribution across the width of the boiler. With the superheater in this location, practically uniform steam temperatures are obtained, the claim being that the variation in superheat is within 15 to 20 deg. from 100 to 350 per cent of rating.

An effective furnace volume of about 6,000 cu.ft. has been provided for each boiler. The setting is of the hollow-wall, air-cooled type, with dampers designed to maintain a substantially equal distribution of air to the ducts at different ratings. The highest air temperature in the ducts, attained at normal ratings, is 140 deg. F. The temperature drops as the load increases, owing to the greater quantity of air entering the furnace.

To remove the small quantity of ash that may collect in the bottom of the furnace, sloping pits with air-operated doors have been provided. They discharge into steel hopper trucks.

Draft is supplied by two self-supporting brick-lined steel stacks of 12 ft. diameter at the top and 19 ft. at the bottom, rising 290 ft. above the boiler-room floor. Their structural steel bases tie in with the building steel, and the breeching enters the base of the stack.

Three standard 6-ton mills, one for each boiler, with automatic control on the feed, are belted to induction motors. The fuel supply comes from overhead bins, which are filled from the bunker house by a system of screw conveyors. Motor-driven exhausters on the main operating floor draw the prepared fuel from the mills and discharge to cyclones at the top of the building, from which the coal drops into 75-ton pulverized coal bunkers, one for each boiler. The return air lines from the cyclones to the mills are carried above the roof, and the vents discharge to a header through which the primary air fans draw their supply. Air-pressure relief valves are set to open when the pressure exceeds ½ in. of water. This ingenious arrangement conserves the waste, keeps the dust discharge within the system and, by preventing its escape to atmosphere, eliminates a possible nuisance.



The compact arrangement of the plant was an important factor in reducing building costs and facilitates operation

Since the coal burned carries little moisture—never over 4½ per cent and usually between 3 and 3½—driers were omitted. Moisture from the coal collects principally in the air return lines to the mills. Introduction of a drop leg 3 ft. deep at the base of this line where the right-angle turn is made into the mill practically eliminated trouble by reducing the number of cleaning periods from an average of three to one per shift. At the bottom of the drop leg a valve line drains the condensation to the sewer. This arrangement removes moisture in excess of 3 per cent of the coal.

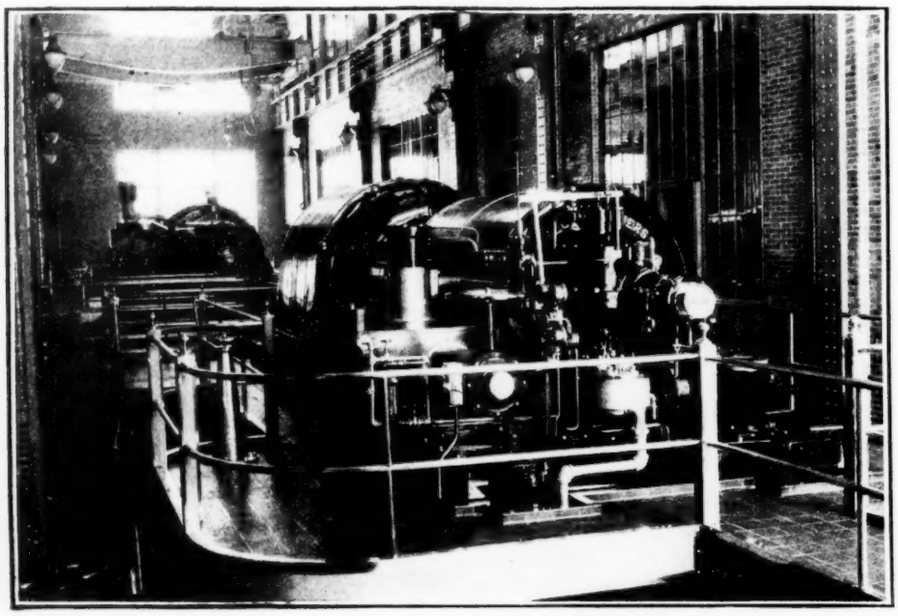
Six vertical burners per boiler are provided. The screw feeders are driven individually by small direct-current motors under automatic control. Primary air is drawn from the cyclone vent header and is forced to the feeders at a pressure of about 15 in. of water. There are three motor-driven fans, and on one of these units the induction motor drive is supplemented by a Ford automobile engine, used when starting the cold plant. This particular fan has connections to either of two boilers.

Over a period of six months the rate of handling and crushing coal averaged 70½ tons an hour. The power requirement was 1.8 kw.-hr. a ton from the coal pile on the storage dock to the raw coal bin in the power house, and the cost 59c. a ton including all operating expense, maintenance, cleaning, etc., of the machinery, tunnels, dock and gantry crane.

In the pulverizing department the coal pulverized per mill per hour averaged 5.4 tons. The power requirement to pulverize one ton to a fineness of 75 per cent through a 200-mesh screen was 19 kw.-hr., including the energy for driving the mill, exhauster, and the pulverized coal conveyor. The cost per ton was 48c., including operation, maintenance, and cleaning as well as the power taken by the primary air fans and the feeder screws.

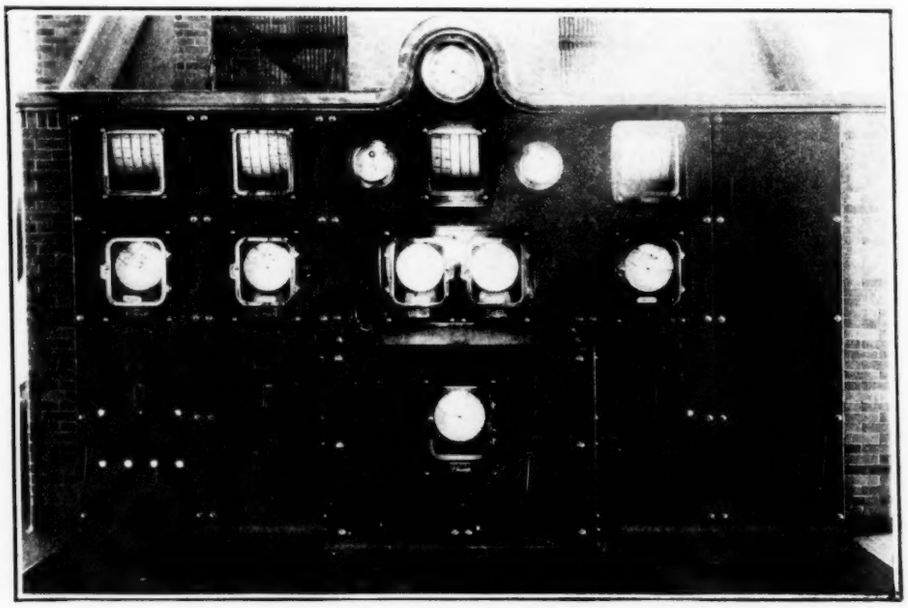
An adequate set of instruments on the central gage board gives a complete check on the boiler-room operation, and remote controls make it possible for one man to handle the normal operating routine. An automatic control system is used to maintain the desired conditions.

Condensate from the condensers and water heaters and returns from the factory provide the major portion of the boiler feed water. Owing to process work, about 8 per cent makeup is required, and this is Detroit River water from the intake tunnel, carrying about eight grains per gallon of incrusting solids. This water is passed through a high-pressure, two-effect evaporator, arranged to furnish steam for factory process heating when this is needed. Returns are delivered to a hot-water surge tank in the evaporator room, with an over-

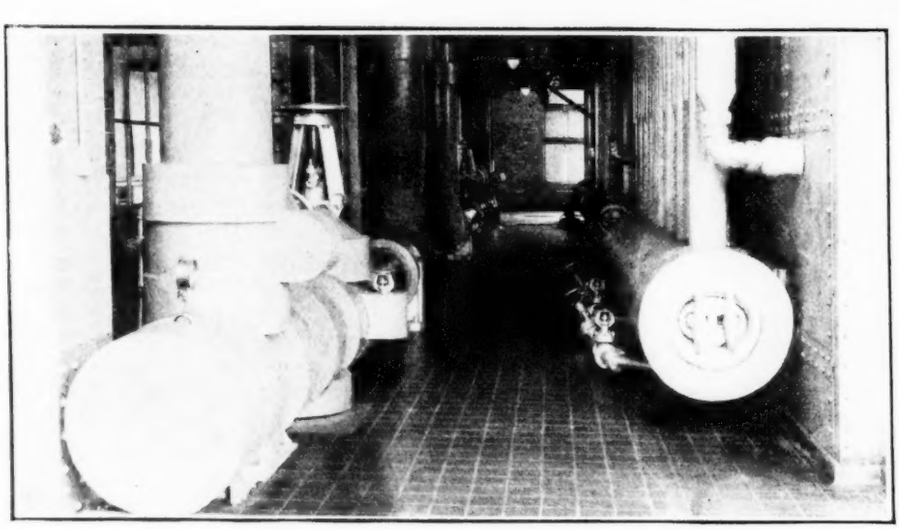


Glimpses of the

The turbine room is arranged for economy of space, and the open floor provides natural light for the condenser basement

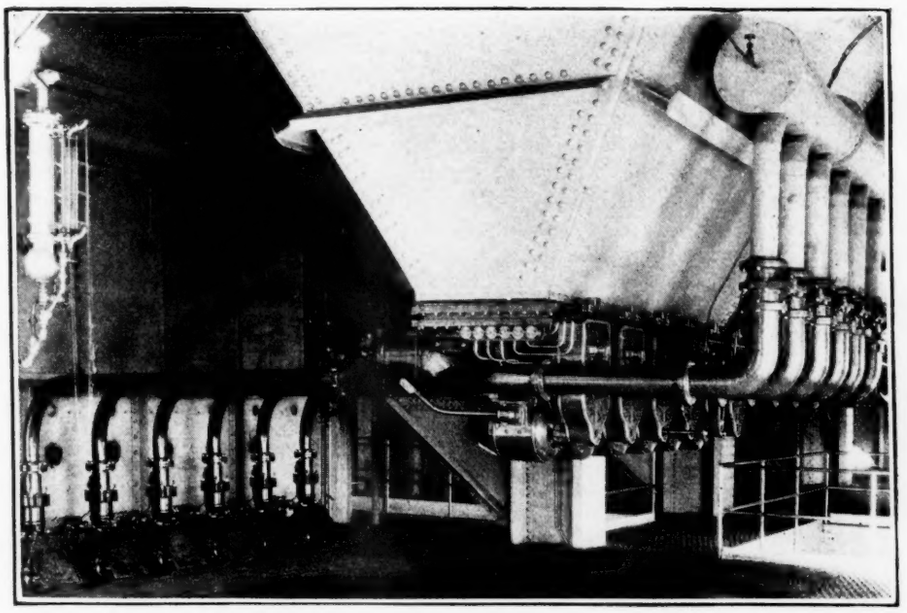


Behind this attractive gageboard is a small laboratory and instrument maintenance shop

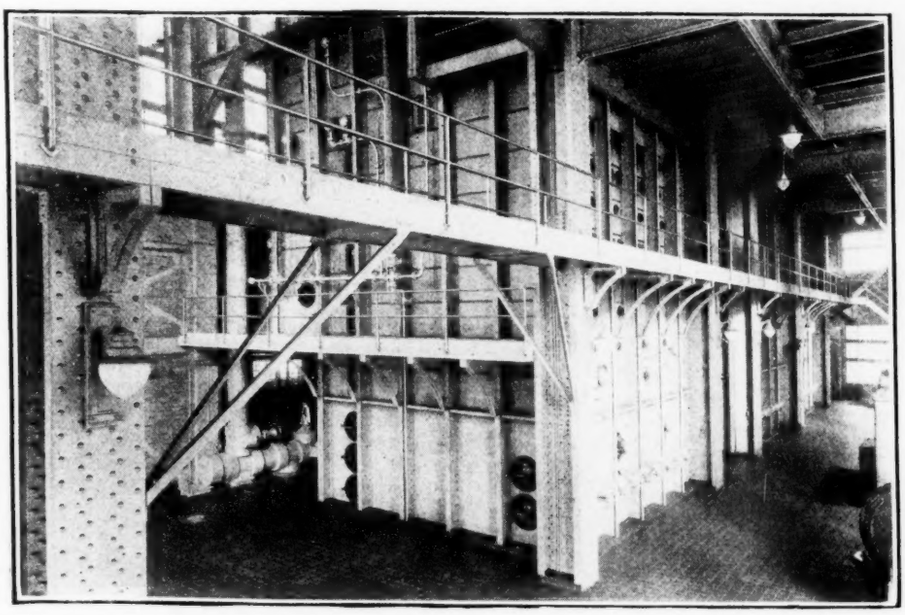


Steam from the boilers enters the short manifolds shown at the left. These are connected by flexible U-bends and feed the turbines through short direct leads. At the right is one of the water-screen drums

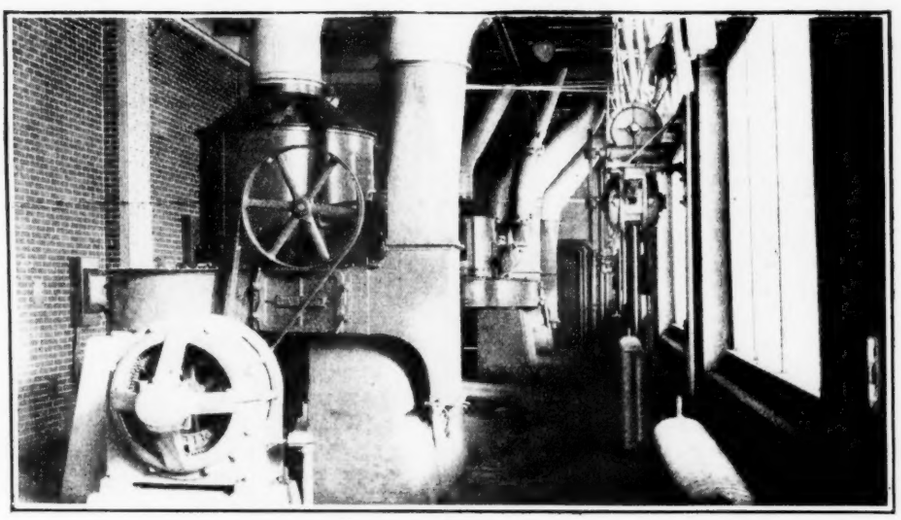
Ford Power Plant



Everything is easily accessible on the feeder gallery. In the upper right corner is the primary air header supplying the burners



The boiler room is noteworthy for beauty and cleanliness. The paint is a light gray, and all railings are nickel-plated



The pulverizing mills are immediately beneath the boiler-room firing aisle, in a room by themselves, provided with ample window area to comply with safety-code requirements

flow to a large reservoir under the pulverizer floor and adjacent to the pumproom. The surge tank is at an elevation giving a head of 18 ft. on the boiler feed pumps. The suction line is connected to both tanks, with automatic valves so arranged that the pumps draw from the surge tanks until the level falls unduly, when water is taken from the storage reservoir.

There are two feed pumps, one motor and one steam driven, each having capacity to supply three boilers. Special Y-fittings on the discharge permit a two-line feed to double-loop headers. Valves at both ends of the loops provide adequate flexibility. Each boiler has a feed connection from either loop.

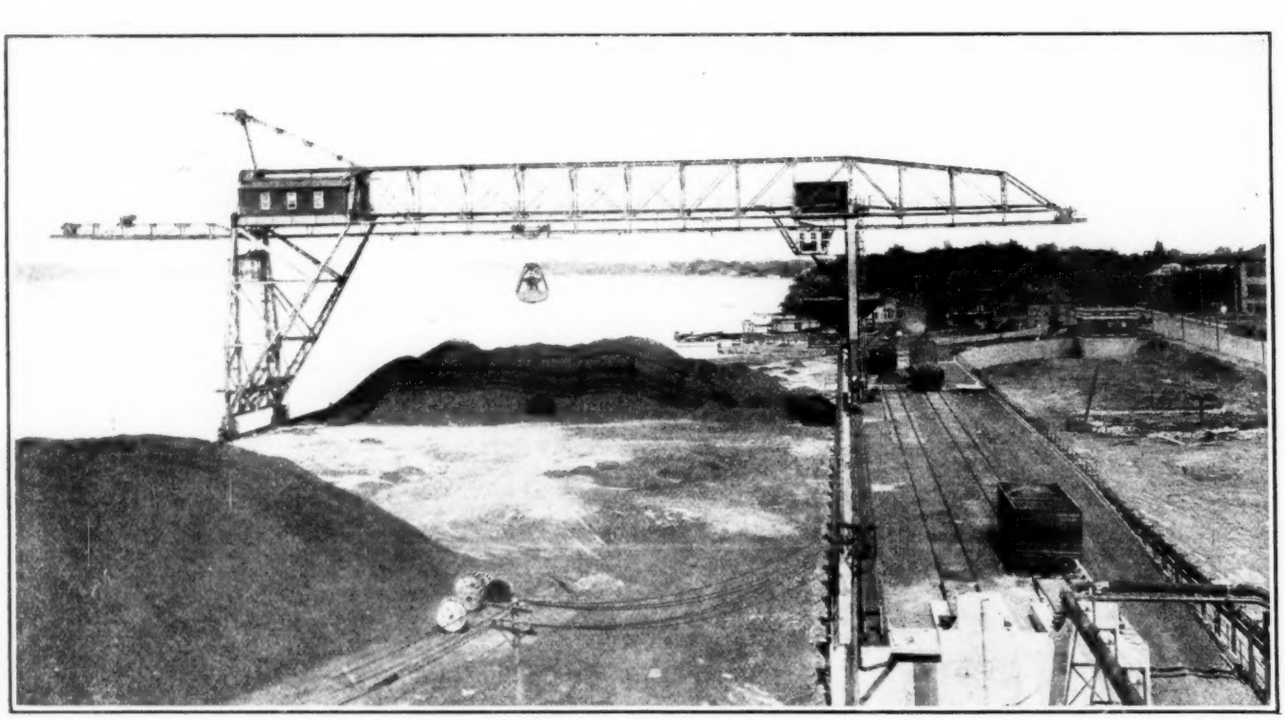
Turbine Equipment

Two generating units have been installed, one rated at 10,000 kw., the other at 5,000 kw., with speeds of 1,800 and 3,600 r.p.m., respectively. The generators deliver three-phase 60-cycle current at 4,600 volts. The pumps discharge to a common header, and as many pumps as are needed to meet the requirements of the two units are operated in parallel. This has proved to be a particularly flexible and convenient arrangement.

Cooling water is drawn from the river through a vertical revolving screen with motor-operated gates front and back, so that the screen pit can easily be dewatered. The screenhouse is of minimum size with removable slab roof construction providing for screen removal. A discharge tunnel of the same cross-section as the intake, 6 by 6 ft., returns on top of the intake, bypassing the screenhouse and discharging downstream.

In supplying electrical energy to the factory, the distances involved called for alternating-current transmission at generator voltage. Centrally located motor-generator sets develop direct current for various departments of the factory.

For power-plant auxiliary drive, transformers step down the generator voltage to 440 volts and all motors



This gantry unloads and handles coal. In the right background is the screenhouse

machines are mounted on structural-steel columns filled in with concrete and capped by a heavy mat 20 ft. above the basement floor. Between the columns solid concrete walls rigidly support the condensers, and under the generator a U-fin type of cooler is suspended through which the generator cooling air is recirculated in a closed system. In a pit 3 ft. below the basement floor are the motor-driven condensate pump immediately under the hotwell of the condenser, a built-in V-notch meter in the condensate well, the oil filter for the unit and two small centrifugal pumps, one for oil and the other for gland water. With the circulating pumps located in the pumproom, the turbine-room basement is pleasantly free from small equipment and piping. This is one of the attractive features of the plant.

Included in the adjacent pumproom are the circulating pumps, three in number, each having a capacity of 10,000 gal. per min. and driven by a 75-hp. motor. The excepting those on the pulverized coal feeders are of the three-phase induction type. The feeder motors are variable-speed direct-current machines and receive their energy from the exciter bus supplied by two motor-generator sets with a storage battery floating on the line.

As the power house has no connection with any outside source of energy, a stand-by dual unit consisting of a steam turbine driving two generators, one alternating-current and the other direct-current, has been provided. In starting the plant cold the alternating-current generator supplies energy to the motors of the circulating and condensate pumps and the direct-current machine excites the fields of the main generators. This unit will function under a steam pressure of 50 lb., which is below the pressure at which the head on the city water mains will feed the boilers.

In heating the factory, distance again was the con-

trolling factor in selecting a forced hot-water circulating system. To supply heat to the water, several combinations of variable-vacuum and bleeder type turbines were considered. It was finally decided to equip both machines so that they could be operated full condensing when factory heating was not required. During the heating season the cooling water for either turbine is circulated through the heating system. A constant quantity of 6,500 gal. per min. is circulated against a 55-ft. head, and variable heating requirements are met by changing the vacuum on the condenser to give the desired water temperature.[1] This is done by the simple expedient of opening an ordinary globe valve on the exhaust nozzle of the turbine to admit air to the condenser. With the vacuum broken to the degree desired, the steam consumption of the turbine increases and also the temperature of the exhaust steam, thus increasing the temperature of the water to meet the requirements. A change in the other direction is made by injecting cold water into the water line carrying returns from the heating system, and spilling excess hot water through a relief valve on the return line.

A bleeder connection is provided on both machines to supply steam at 5 lb. pressure for factory process at the same time that the unit is operating on variable vacuum. If it is desired, the water of the heating system may be circulated through a heater instead of the turbine condensers. Both condensers were designed to withstand 100 ft. head on the circulating water, so that they can be used with safety on the heating service. It will be apparent that the over-all economy is considerably greater than when operating straight condensing, as no heat is carried off to the river in the circulating water.

Experience indicates that the lowest vacuum required to heat the factory buildings is 16 in. and that no condenser circulating water will be dumped into the river from December to March. For the 5,000-kw. unit the steam rate at full load ranges from 12.6 lb. per kw.-hr. at 29 in. vacuum to 16.4 at 16 in. vacuum. At the latter vacuum the large unit will develop about 8,000 kw., and at this load the steam rate ranges from 11.4 at a vacuum of 28½ in. to 19.1 at 16 in.

A Detailed Comparison

The power demand for a typical winter month was 2,027,000 kw.-hr., and the factory heating demand was 45,942 million B.t.u. Had the factory been heated by hot water heated by steam extracted from a bleeder turbine at 5 lb. gage pressure the average rate of heat supply would have been $\frac{45,942,000,000}{31 \times 24} = 61,750,000$ B.t.u. per hour and, since the heat of vaporization of steam at 5 lb. per sq.in. gage is 960.6 B.t.u. per lb., the steam demand would have been $\frac{61,750,000}{960.6} = 64,276$ lb. steam per hour at 5 lb. gage.

During the same period the average turbine load was $\frac{2,027,000}{31 \times 24} = 2,724$ kw. The steam consumption of a 5,000-kw. bleeder turbine under these conditions would be approximately $2,724 \times 22 = 59,928$ lb. per hour entering the turbine throttle, of which 21,000 must pass to the condenser to avoid overheating the low-pressure turbine blading, leaving 38,928 lb. per hour available for extraction for building heating.

Since this is inadequate, the shortage of 25,348 lb. per hour would have to be made up from other sources, partly exhaust from auxiliaries and partly live steam through reducing valves. Thus the total steam required for power and heating would be $59,928 + 25,348 = 85,276$ lb. per hour.

During this same month, with actual operation under variable vacuum conditions, the steam supplied to the turbine was 49,900,000 lb., or 67,070 lb. per hour average. This shows an average saving of 18,206 lb. per hour or a total saving of 13,545,264 lb. for the month, over the extraction heating plan. Charging this steam at 45c. per thousand pounds gives a saving for the month of $6,095, and the use of a single set of pumps for both condenser and heating system water circulation brings the total close to $6,400 for the month.

With a combined power and heating load the most economical combination is that which carries both loads with the minimum rejection of heat to the river. In this plant the only heat thus lost is during the time when the load is coming on in the morning, for about 15 minutes.

Plant Appearance and Good Housekeeping

An outstanding feature of the plant is its splendid appearance. With walls and floors tiled in harmonizing colors and with all equipment finished like a high-grade automobile body, with a generous use of nickel plating, the plant seems almost like a museum. The operating men are charged with keeping everything clean and bright, and there is not a trace of dirt or water anywhere. The housekeeping practiced in this plant should serve as an ideal toward which every operating engineer should strive continually. It pays to have a plant that men can be proud of.

And yet the plant is not merely a show place. It is a sensible, matter-of-fact power and heat generating unit that is turning out power for about 1.1c. per kw.-hr. gross, and for 0.8c. when credit is allowed for the heat supplied to the factory.

Windmill Tests

Although windmills have been in use for more than a thousand years, accurate data as to their efficiency cannot easily be obtained. The Institute of Agricultural Engineering of the University of Oxford has therefore made a useful contribution to our knowledge of the subject by publishing a report on the use of windmills, more especially for the generation of electricity.

A windmill experimental station was erected on the Annables estate, midway between Harpenden and Luton, and seven windmill plants of various types have been erected on it. Economic, technical and meteorological observations have extended over a period of one year. The cost per electric unit utilized varied between 12.7 pence and 4.0 pence. By using improved wheels the cost of production for the smaller and more inefficient mills could be reduced by 30 or 40 per cent. Considering the very small dynamos used, having an output of only a few horsepower, these results are quite satisfactory.—*Nature, Vol. 118, Aug. 7, 1926, p. 203.*

[1] For detailed discussion of this method of heating, see *Power*, Vol. 36, page 788 (Nov. 26, 1912), and Vol. 37, page 88 (Feb. 18, 1913), and *The Heating and Ventilating Magazine* for November, 1926, page 76.

Pipe-Line Designations

By A. R. Nottingham

THE piping system in a large plant or building is necessarily complex, and any system of designation that is clear and promotes safety is not only welcome but necessary.

In a small plant where the service and the connections can be seen at a glance and where every man on the job knows every valve and line with certainty, designation may seem entirely unnecessary. Even here some system is desirable to provide for the expansion of the plant and convenience of the operating force, as well as to guide new or outside men. In an emergency an outside pipefitter may have to be called in, or in the case of real emergency someone outside the regular force might need to know with dispatch and certainty which lines should be shut off or opened.

In the small plant the color scheme is quite satisfactory, except to the uninitiated or when obscured by steam, smoke, dirt or semi-darkness, or similarity of color. Colors too often alter appreciably, owing to fading, soil or reaction with an atmosphere such as surrounds much process work.

There is no reason why colors should not be continued as at present where feasible, or used with a system of numbers, which means simply adding to the pipe or to the wall with arrows if necessary, a number in bold contrast to the background, painted with stable prime colors. This number should be fairly short, but in any case a man knows that if the first figure is 1 it is a steam line or an 8 it is a fuel line, etc.

It would seem that this would be of sufficient importance to warrant consideration for a standardized system so that an inspector or anybody in any plant would know the usual combinations with certainty, without referring to the wall chart.

The further objections to the color alone when used in a complex system are: There are not enough colors that are clean-cut and recognizable under all conditions, or color combinations that are clear to the average person or remain clear during the life of the pipe. Different colored bands on the pipe or colors of fittings represent an excellent suggestion for the extension of the system, but have practical limitations and add to the cost.

Painting, while usually desirable, may in some cases be unnecessary, and it means painting the entire line just to show the fluid it carries. In some cases, too, it is undesirable, as on pipes subject to internal corrosion only, where the paint might prevent the discovery of corrosion until the pipe was ready to collapse, or in the case of radiating surface where the paint makes it less efficient.

The desired color may not be in harmony with the surrounding colors or background. This is especially true in offices where the desirable color scheme may violate the designation code. In this case the painting of the pipes to suit the occupant and a moderate-sized clean-cut number neatly stenciled on it in sharp contrast would seem to be a satisfactory solution.

A system such as given in the accompanying table has unlimited possibilities. It should not, in any given plant, be made more complex than is necessary. Too much or too little designation can be given when the piping is complicated. A reasonable amount on the actual pipes, adjacent walls, or in special cases on a tag, as for instance multiple gage lines run in restricted passages to the board, and the rest as layouts, charts or book records, is the better solution.

It is only necessary to take as much of the system as necessary to the particular plant and apply it, and post in a permanent form suitable wall charts for instruction and reference.

The assigned designation is to be put on the pipe as erected at suitable intervals and on both sides of partitions and floors.

The erectors may make this a temporary free-hand marking or a permanent marking as desired, using a paper or metal stencil. This would be furnished and filed for further use.

PIPE LINE DESIGNATIONS AT THE ACHILLES POWER CO.
Iota, Michigan

The contents and normal condition of the contents are shown by figures placed on or adjacent to the pipe line. The number will be kept as short as practicable and give all desired information. X indicates a figure omitted as not necessary or not applicable. Where a special character is necessary, list at ( ) below and in records.

Illustration: 22 indicates an ordinary water line which may be used for drinking water.

123—Designation. 1203—To building and floor. 2523—Unit served. This indicates a steam line of medium pressure and of minor importance and condition connecting to building 12, third floor, serving oven No. 23 (experimental). Conditions normal unless otherwise specified.

Index	First Figure	Second Figure	Third Figure	Fourth Figure
1	Steam	High pressure	Major or main line (branch)	Especially pure
2	Water	Medium pressure	Secondary line (heating)	Nominally pure
3	Air (or inert gas)	Near atmosphere	Minor line	Contaminated
4	Gas (inflammable)	Moderate vacuum	Return line	Foul
5	Duct, conduit or conductor	High vacuum	Drain	Neutral
6	Ammonia or other refrigerating fluid except air	High temperature	Bypass (minor)	Reclaimed
7	Chemicals. CAUTION	Moderate temperature	Parallel main	Fire service
8	Fuel, combustible or explosive	Room temperature	Control line	Fire auxiliary
9	Oil (not fuel)	Moderately cold	Gage, inst. or sampling line	Dangerous
10	Brine or similar fluid	Ice cold or colder	Emergency	.....
( )	Special inserted here	.....	.....	.....

Inspection is to be made before the final section or fitting is put in place. The lines are to be blown out with the open ends of the rest of the system guarded to prevent anything from being blown across into it. This would be followed of course by final inspection of the line throughout under pressure.

This may seem unnecessary, but it often happens that a line that is perfectly obvious today may be paralleled for a distance under emergency conditions, or the lapse of time may make the identity uncertain.

Obviously, in a large plant the designer, the erector and the operator find such a system of great assistance. This may be used with an individual number for each line, which is assigned arbitrarily when the line is laid out and used for its individual record in operation, if such is desired. These may be made up simply or in great detail as that where the class of service is indicated according to some such scheme as: 1,000 represents the power piping, 2,000 heating, and 3,000 refrigerating, etc. A more involved system consists of groups of figures, as follows: First number, the pipe designation as in the accompanying table; first figure, kind of fluid; second figure, pressure or temperature; third figure, kind of line (omitted when obvious); fourth figure, condition of fluid (omitted when obvious); dash; the building and floor served; dash; the unit served or the line number.

With the Molecules in the Refrigerating Plant

By G. GROW

A FEW remarks on cooling by a boiling liquid. No one would attempt to freeze water by boiling it, still a boiling liquid is used in all ice plants. Refrigeration, after all, is merely the transfer of molecular energy. This article attempts to outline the fundamentals of freezing.

ONE of the ideas most difficult to grasp by those not versed in refrigeration is that all making of artificial ice and all cold-storage work is performed by a boiling liquid. In fact, the dancing of the South Sea medicine man upon red-hot rocks is no more startling to the average person than is the statement that a finger can be thrust into a boiling liquid without being burned. All know that water must be scalding before it starts to boil, and from this many reason that a boiling liquid must be hot.

Boiling and high temperatures are not inseparable companions, and it is possible to have a liquid boil at a temperature so cold that upon being thrust into the ebullating mass, one's finger would become as cold as an icicle. Although 212 deg. F. is broadly called the boiling point, it is the temperature at which only one liquid, water, boils and then only where the vapor pressure over the liquid is equal to atmospheric, or zero gage, which is 14.7 lb. on the absolute pressure scale. If a higher pressure exists, even water will refuse to boil until the temperature is increased. Conversely, if the pressure be less than atmospheric, boiling of water will begin before a temperature of 212 deg. F. is reached; for example, at 4 lb. absolute pressure the boiling temperature is 162 deg. F. Other liquids, when exposed to similar pressures, require greater or lesser temperatures to boil.

Some liquids, when under ordinary pressures, boil at temperatures even below 60 deg. F.; some do so at a temperature as low as 200 or 300 deg. below zero on the Fahrenheit thermometer. A few of these low-temperature liquids are used in refrigerating systems, for as long as the refrigerator is above their boiling temperatures the liquid will continue to absorb heat from the box and so lower its temperature. For commercial plants ammonia is the prevailing medium, while for household refrigerating machines others, such as carbon bisulphide, methyl chloride, butane, etc., are used in preference to ammonia.

The procedure through which such liquids are used to freeze ice is by no means complicated.

First it is best to outline what boiling means. It, of course, is the rapid formation of vapor from the liquid, but what makes the vapor form and why does not all the liquid form into vapor, or "steam," at the same instant?

For example, let us take a vessel, Fig. 1, in which is placed a quantity of liquid ammonia. This liquid is composed of minute bodies, molecules, which are in continuous motion. Without going deeply into the matter, it can be stated that the temperature of the liquid depends upon the average velocity of these molecules. Conceivably, some of the particles are moving faster than others. The velocity of some of these is sufficient to permit the molecules to overcome the attraction of the others and escape into the space above the liquid. If the vessel has no cover, these molecules escape to the atmosphere and we say that part of the liquid has evaporated. If the vessel has a cover, the molecules, as in Fig. 2, bombard the walls of the vessel and some re-enter the liquid; if the pressure does not rise, those entering are equal in number to those leaving the surface. The pressure exerted by these molecules, which are now very far apart compared to their individual mass, depends upon the velocity and number of times they strike the containing walls. If the heat be applied to the liquid, the velocity of the molecules increases, as evidenced by the rise in

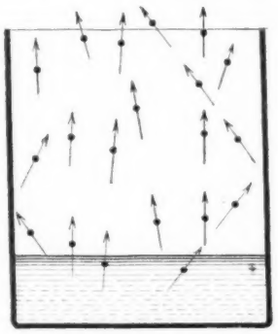


Fig. 1—The high-speed molecules leave the liquid

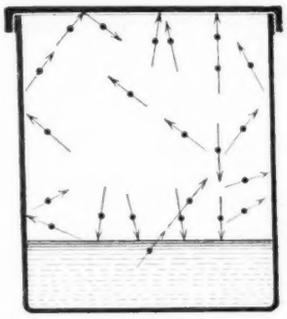


Fig. 2—In a closed vessel pressure is due to molecules striking the walls

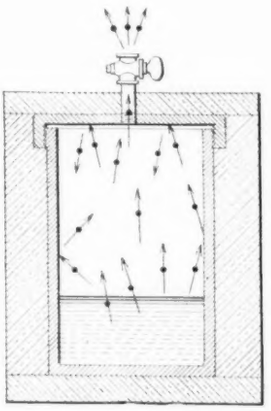


Fig. 3—The highest-speed molecules escape, reducing interior pressure

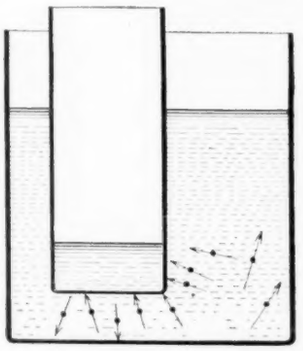


Fig. 4—Heat flow is a transfer of molecular energy

temperature, and more escape into the steam space, the increased velocity producing a pressure increase.

Let it be assumed that the ammonia is in the condition already outlined, that is, contained in a closed vessel and at a temperature of, say, 80 deg. F. The velocity of the ammonia molecules at 80 deg. F. is such that those escaping above the liquid level exert a pressure of 140 lb. gage. Suppose the tube now be covered by an insulating material, as in Fig. 3, so that no heat can enter and none escape. The pressure will then remain constant since the molecular velocity is unchanged.

Now let the cock at the outlet be opened slightly so that some of the ammonia vapor escapes. Obviously, the higher-speed molecules will be most numerous of those passing out. Since there are not now so many molecules above the liquid and those left have a slower

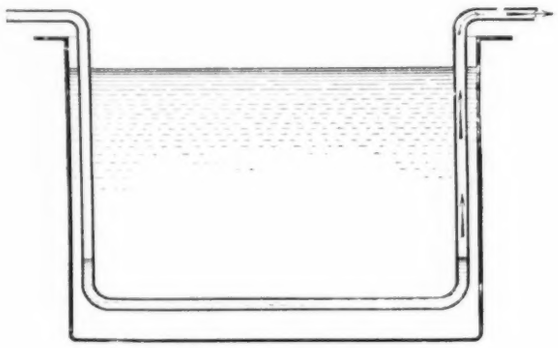


Fig. 5—The action of superheating

speed, the pressure will drop. Continued escape of the ammonia vapor will result in a reduction in the average velocity of the molecules, and the temperature of the remaining liquid will decrease. This process may be continued until the pressure is, say, 15 lb. gage, at which point the average velocity of the remaining molecules is such that the thermometer registers 0 deg. F.

Suppose we now remove the insulated covering and immerse the vessel in brine which is at, say, 30 deg. F. The brine molecules are in motion and on striking the ammonia container increase the vibration of the molecules making up the walls. These in turn increase the vibrations of the ammonia molecules. In order to transfer energy in heat from one substance to another with any degree of speed, there must be a considerable difference in the relative velocities; in other words, a difference in the two temperatures. With heat, or molecular vibration from the water passing through the walls, the velocities of the ammonia molecules will rise and will become sufficient to overcome the attraction of the other molecules and will pass from the liquid level into the space above. So fast do part of the molecules acquire an increase in velocity that the cohesion or attraction of the slower-speed molecules is overcome while the high-speed ones are still far below the surface. As a result, vapor bubbles, made up of a mass of these fast moving molecules, form and rush upward into the steam space, the action being called "boiling."

If the exit cock be properly manipulated, the pressure will remain constant at, say, 15 lb. and the temperature at 0 deg. F. The continued flow from the brine to the ammonia will lower the brine temperature until after a sufficient length of time it is almost the same as that of the ammonia. Practically there will always be a temperature difference since the brine is continually absorbing heat or molecular energy from outside sources.

It will be noted that with the ammonia at room temperature the first action is the evaporating of part of the ammonia to create a vapor pressure corresponding to the temperature. In an actual ice plant this condition exists in the condenser and receiver when the pressure is that at which ammonia will condense into liquid or the liquid boil into vapor at the existing temperature.

At a reduction in pressure it was found that more of the ammonia evaporated. This actually happens when the liquid ammonia passes from the high, or receiver, pressure to the evaporation coil pressure. Part of the liquid evaporates and forms vapor, so that the fluid actually entering the coil is a combination of liquid and vapor. The temperature has dropped, but all the cooling effect has been upon the ammonia itself, and no effective cooling is performed until the ammonia can absorb heat through the coils from the brine or refrigerator.

Suppose now the tube be made in the form of a long coil, with the liquid ammonia at the bottom, as in Fig. 5. Vaporization or boiling will continue as before, but the vapor passing up through the long tube will pick up more heat and its molecular velocity and temperature will increase above the 0 deg. which it had on leaving the liquid, but as the outlet offers a means for the molecules to escape, the pressure does not increase. This increase in temperature above that corresponding to the pressure is called superheating and increases the volume of gas leaving the coil.

Ammonia, or any of the other refrigerants that must be purchased, cannot well be thrown away, consequently the valve control of the exit is not commercially feasible. To remove the vapor and put it in a condition where it can be re-used is the function of the compressor, which will be discussed in a second article.

Lubrication of Refrigerating Machines

In many vertical and horizontal refrigerating machines, especially the larger types, pressure lubrication is used with marked success. More accurate control of the amount of oil delivered to cylinder walls and compressor bearings is possible with such a system.

One of the chief advantages of pressure lubrication, however, is the possibility of effective filtration or purification of the oil if it is to be recirculated. With a splash oiling system this can be done only when the crankcase is drained.

On many types of machines it is good practice to lubricate internal and external parts individually; in other words, using the mechanical lubricator with perhaps three outlets for cylinder and stuffing box service, and an independent gravity or mechanical pressure circulating system for all external bearings.

For these latter a high-grade engine or machine oil will suffice. Low pour test and exacting flash point requirements for this type of work are relatively immaterial; it is only essential that the viscosity be sufficient to carry the bearing loads and that the oil is conducive to ready separation from foreign matter and impurities.

Mechanical force-feed lubricators are also adaptable to cylinder lubrication via the oil lantern, or oil recess within the piston rod stuffing box.—*Lubrication.*

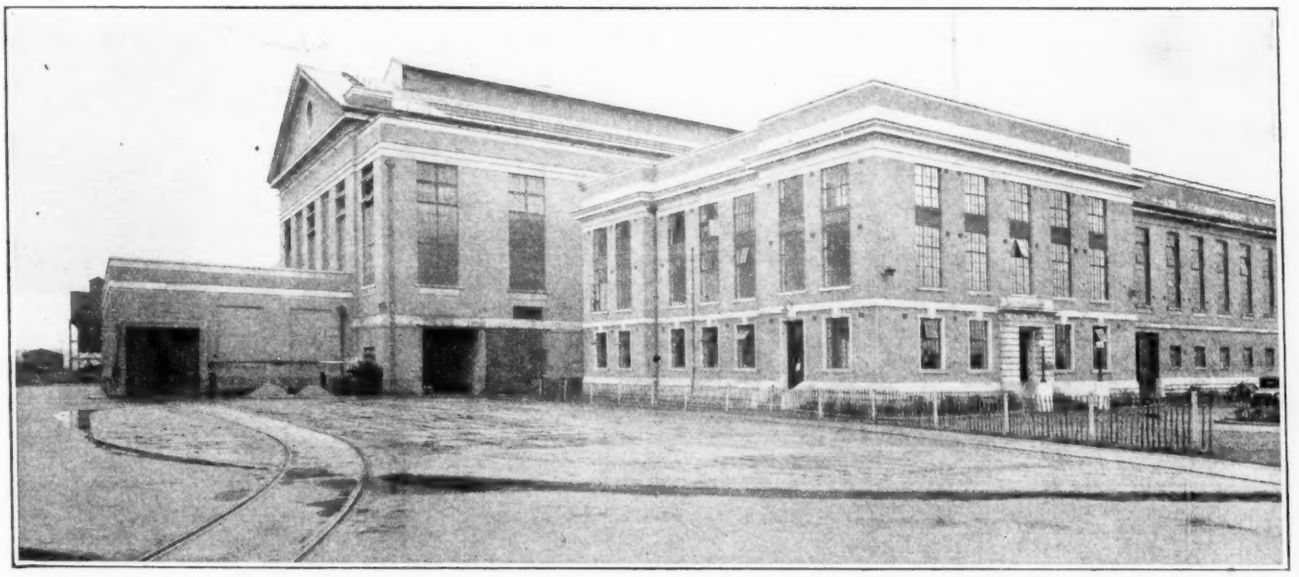


Fig. 1—Barking Station illustrates how the factory appearance so prevalent in power houses can be avoided

Addition to Barking Station, Part of London's Electrical Consolidation

THE new boiler house of the Barking station of the County of London Electric Supply Co., Ltd., will be built at right angles to the turbine room in a similar manner to that of the first half-section of the station. It will be a steel-frame, brick-clad structure with a flat roof finished in concrete and asphalt.

The first half-section of the station was officially opened by King George V, on May 19, 1926. It comprised a boiler house containing twelve boilers and four preheater units complete with chain-grate stokers, and a turbine house containing four turbo-alternator sets, two of 40,000 kw. and two of 18,750 kw., complete, with condensing plant, etc. The boiler-house plant now under construction will complete the first section of what promises to be one of the largest generating stations in the world.

Ten Units To Be Installed

For the present ten Babcock & Wilcox cross-drum marine boilers will be installed in two parallel lines, back to back, five in one line and five in the other. Each boiler will have a heating surface of 16,300 sq.ft. with a normal evaporation of 135,000 lb. and an overload capacity of 187,500 lb. of steam per hour at a pressure of 375 lb. per sq.in. Each unit will be fitted with a convection-type superheater of approximately 4,500 sq.ft., capable of superheating the steam to a temperature of 725 deg. F. on normal load, and to 765 deg. when working at maximum capacity.

A steel-tube economizer and an air heater are to be fitted to each boiler unit. The economizer is to have a heating surface of 6,100 sq.ft., while the air heater will have 23,250 sq.ft.

The Lopulco central system of pulverized-coal firing is to be adopted, a diagrammatic arrangement of the essential functional units in this system being shown in Fig. 2.

Above and in front of each line of boilers are two lines of raw-coal bunkers having a capacity of 2,800 tons, the raw coal being fed to these by an elevator. A magnetic separator for removing tramp iron or other foreign matter from the coal, is located between the receiving hopper and the raw-coal elevator fillers. From the bunkers the coal is discharged through gates to the driers, which are of the steam-heated rotary type, driven by a 3-hp. variable-speed motor. There will be two driers per boiler unit. When the coal contains not more than 6 per cent free moisture, the raw coal will be fed by means of a bypass chute not shown, direct to the pulverizing mills.

The mills, one per boiler unit, are to be of the Raymond roller type, each having a capacity of 15 tons per hour.

The segregation of the finely ground material from the coarser unground particles will be effected by air separation. From the top of the mill the mixture of air and pulverized coal passes through the exhauster fan, thence into a vertical duct, and is finally discharged into a cyclone separator which will be installed at the top of the building. In the cyclone the powdered coal is thrown out, the air returning to the bottom of the mill for continuous recirculation.

From the cyclone separators the pulverized coal is discharged through automatic flap valves and bifurcated chutes into two screw conveyors which in turn deliver it to the storage bins. One bin, having a self-trimming capacity of 126 tons, will be provided for each boiler unit. The screw conveyors are arranged so that any one mill can feed into any storage bin, thus insuring a supply of powdered coal to any boiler unit should the

mill associated with it break down. The primary air, which constitutes approximately 15 per cent of the total air required for complete combustion, is introduced and intimately mixed with the coal at the outlet from the feeder.

The combustion chambers will be fitted with water screens and water-cooled side and back walls. These water-cooled walls will be interconnected, and coupled to the steam drum of the boiler so as to insure an active circulation through the tubes when the boiler is in operation. While their main function will be to cool the ash below its melting point and to prevent slagging of the walls of the combustion chamber, the additional heating surface provided will be highly efficient. The water-cooling elements will be built up of fin tubes, 4 in. in diameter and fitted with a pair of diametrically opposed fins welded on. Pitched 7 in. apart, with ½-in. clearance between the fins for expansion, a practically continuous metal surface will be exposed.

The front wall of the combustion chamber will be of hollow construction, the secondary air being introduced into the furnace through a large number of damper-controlled ports disposed throughout the front wall.

Each boiler unit will be fitted with one forced- and two induced-draft fans with a common chimney for each pair of boilers. The latter will be of the self-supporting type, 11 ft. 9 in. in diameter, and will reach 123 ft. above the level of the boiler-house basement. Each will be fitted with a center baffle plate between the points of entrance of the flue gas from the two boilers. To each chimney will be fitted a dust extractor, capable of extracting at least 75 per cent of the dust and grit.

Six boiler-feed pumps of the Weir combined motor- and steam-driven type will be provided, each combined pump being capable of delivering up to 250,000 gal. of feed water per hour, the maximum pressure at the discharge branch being 485 lb. per sq.in. The water at the inlet of the pumps under normal running conditions will have a temperature of approximately 215 deg. F.

The steam supply for the turbine pumps will be taken from the high-pressure pipe system in the turbine room at a pressure of 350 lb. per sq.in.

Six evaporators of the Weir type are to be provided, each capable of evaporating 7,500 lb. of raw water per hour. Each has associated with it a preheater, the necessary strainers, etc.

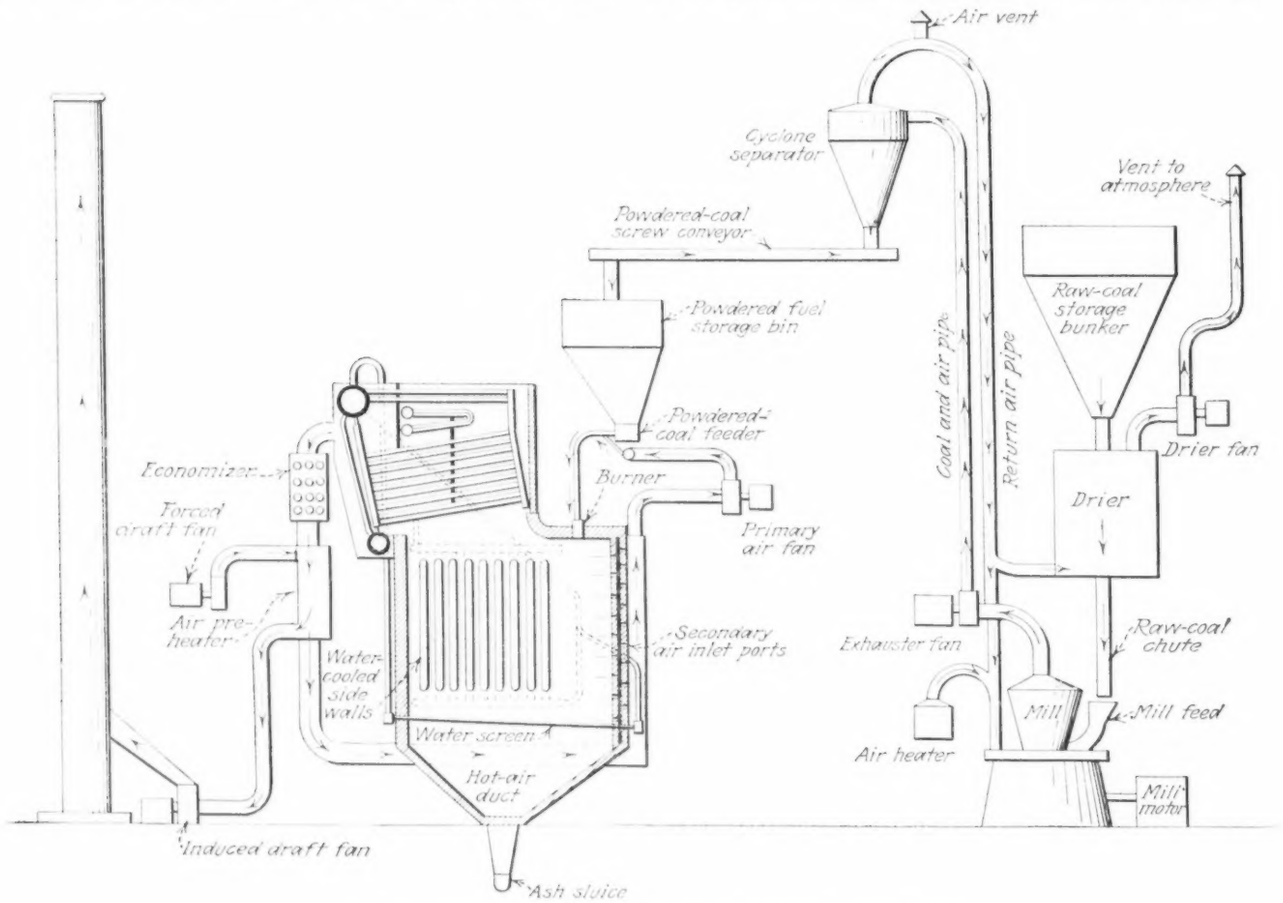


Fig. 2—Diagrammatic plan of the boiler-room equipment

The electric supply of London, like many other large towns, is in a stage of transition and it is a little difficult to grasp the magnitude of the figure involved. For example, the total area covered is 1,900 square miles and contains within it the City of London, 28 metropolitan boroughs, 3 county boroughs, 14 municipal boroughs, 88 urban districts, 20 rural districts and boroughs, and part of a number of other rural districts, there being about 88 different authorities for the supply of electricity, having about 77 main generating stations, a large number of which are of relatively small size.

It is hoped eventually to supply the whole of London, which has a population of about 7,000,000 inhabitants, mainly from four to five other generating stations built on the same lines as Barking.

Direct Current Elevator Controllers—

Operation of a Two-Speed Full-Magnet Type

By CHARLES A. ARMSTRONG

THE controller described in this article involves a great many fundamental principles and therefore provides an interesting study not alone from the practical side, but also of basic principles, all of which have been brought out in the story.

ELEVATORS operating at a car speed of 100 ft. per min. or less can be controlled with a single-speed controller without any slow-down. At higher speeds slow-downs must be provided in the control equipment so that the operator can reduce the speed of the car so that an accurate landing can be made.

For example, if a car operates at 150 ft. per min., the control equipment can be arranged to give two speeds, say 75 and 150 ft. per. min. The motor on such an equipment would operate at a speed with all the starting resistance and the series field winding cut out, to give a car speed of 75 ft. per min. To obtain the 150 ft. per min. car speed, the field current is reduced to double the motor's speed. Another method of obtaining two speeds is to use two shunt-field windings, one of which is cut out of circuit to obtain the high car speed. The higher the car speed the greater the number of speed-control points that must be provided. Some controllers have seven or more speed points on the car switch.

The Gurney Elevator Co.'s controller, Fig. 1, is one type designed to give two car speeds from the car switch and is known as the type 42-*B*. What the different contactors are for is given under the figure, and how the controller functions will be made clear by the following description of the circuits shown in Fig. 2, which are for a traction elevator machine.

On this type of controller the up or down direction switches *U* and *D* also act as a line switch to make and break the line circuit, and they are equipped with blowout coils *B*, B_1 and B_2 to assist in quickly interrupting the arc at the contactors. Coil B_1 is between the two contactors and is effective on whichever contactor is in use.

Assume that the car switch is closed to point 2 for up motion. Closing the 2 contact on the car switch completes the circuit through the coil of the up-direction switch *U*, from the + side of the line to the throw-over switch *A* and to 1 on the car switch. This part of the circuit is common to all four circuits made through the car switch. From 1 on the car switch the circuit is to 2 and to 2 on the top hoistway limit switches, returning to 8 at the bottom of the controller, through the coil on the up-direction switch *U*, part of resistance R_4 at the bottom of the contactor *D'* and to 6 at the bottom of the controller. From 6 at the bottom of the controller the circuit continues to 6 on the car-gate switch, through this switch and the safety and emergency switches and back to 7 at the bottom of the controller and to the — side of the line. This circuit can be easily followed out on the simplified diagram, Fig. 3.

Energizing the coil on the up-direction switch causes this switch to close and completes the motor circuit. The armature circuit for the motor is from the + side of the line, through blowout coils B_1 and *B*, the top left-hand contact of switch *U*, through the coil on the overload relay *OL*, to A_1 on the motor. The circuit is then through the armature and to A_2 on the controller,

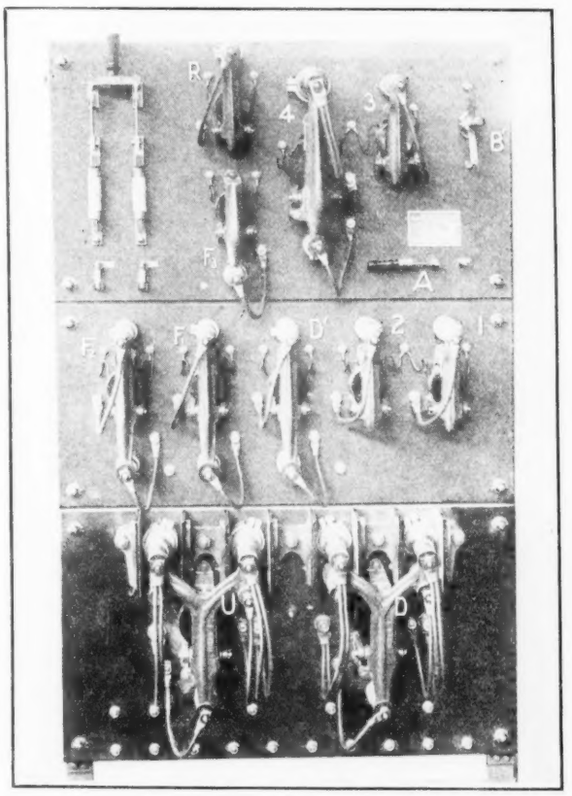


Fig. 1—Two-speed direct-current elevator controller

U—Up-direction switch. *D*—Down-direction switch. Contactors 1, 2, 3 and 4 cut out the armature resistance. Contactors F_1, F_2 and F_3 cut in the field resistance. *D'*—Dynamic-brake and non-interference magnet. *R*—High-speed relay. *B*—Control switch for operating elevator at slow speed from control panel. *A*—Switch to change from car-switch control to control on the panel board.

through all the starting resistance between A_2 and R, to the top right-hand contact on direction switch U and to the — side of the line.

The field circuit is completed from contact 12 on the up-direction switch to 12 on the motor through the field winding and back to 13 on the control board. If the inrush current through the overload relay OL is sufficient to close this relay and hold it closed, the shunt-field circuit is from 13 at the bottom of the controller through the overload relay and to the — side of the line. If the overload relay is open, the shunt-field circuit is from 13 at the bottom of the control panel, through the bottom contacts of field relays F_1, F_2 and F_3 to the — side of the line.

A circuit is provided for the brake coil from terminal 12 on the motor, through the brake coil to 10 at the bottom of the controller, through the bottom contact on contactor No. 4, to 10 on direction switch U, to the top right-hand contact of this switch and to the — side of the line. Energizing this circuit releases the brake and allows the motor to start.

The starting resistance is cut out of circuit by contactors 1, 2, 3 and 4. The coils of these contactors are in series and connected across the armature, so that their closing is controlled by the counter-electromotive force developed by the armature. A circuit for these coils is made from the left-hand side of the up-direction switch to a and through resistance R_a, coils 1, 2, 3 and 4 to A_2 on the starting resistance, through all the starting resistance to the right-hand side of the up-direction switch and the — side of the line.

One side of the armature is connected to the right-hand side of the reversing switch and the other to A_2 on the starting resistance. These are the two points to which coils 1, 2, 3 and 4 connect. Since these coils are connected across the armature, they will have a low voltage impressed on them at the instant of starting and will not close their contactors. As the armature increases in speed, the voltage across its terminals increases, and when it reaches a certain value, the pull of coil No. 1 becomes sufficient to close its contactor.

Closing of contactor No. 1 connects R_1 on the starting resistance to the right-hand side of the up-direction switch and cuts out the section of resistance between R and R_1. This increases the speed of the motor and the voltage across its terminals, and the current in coils 1 to 4 reaches a value that causes No. 2 to close its contactor. Closing this contactor cuts out the section of resistance between R_2 and R_1, which further increases the speed of the motor and the voltage across

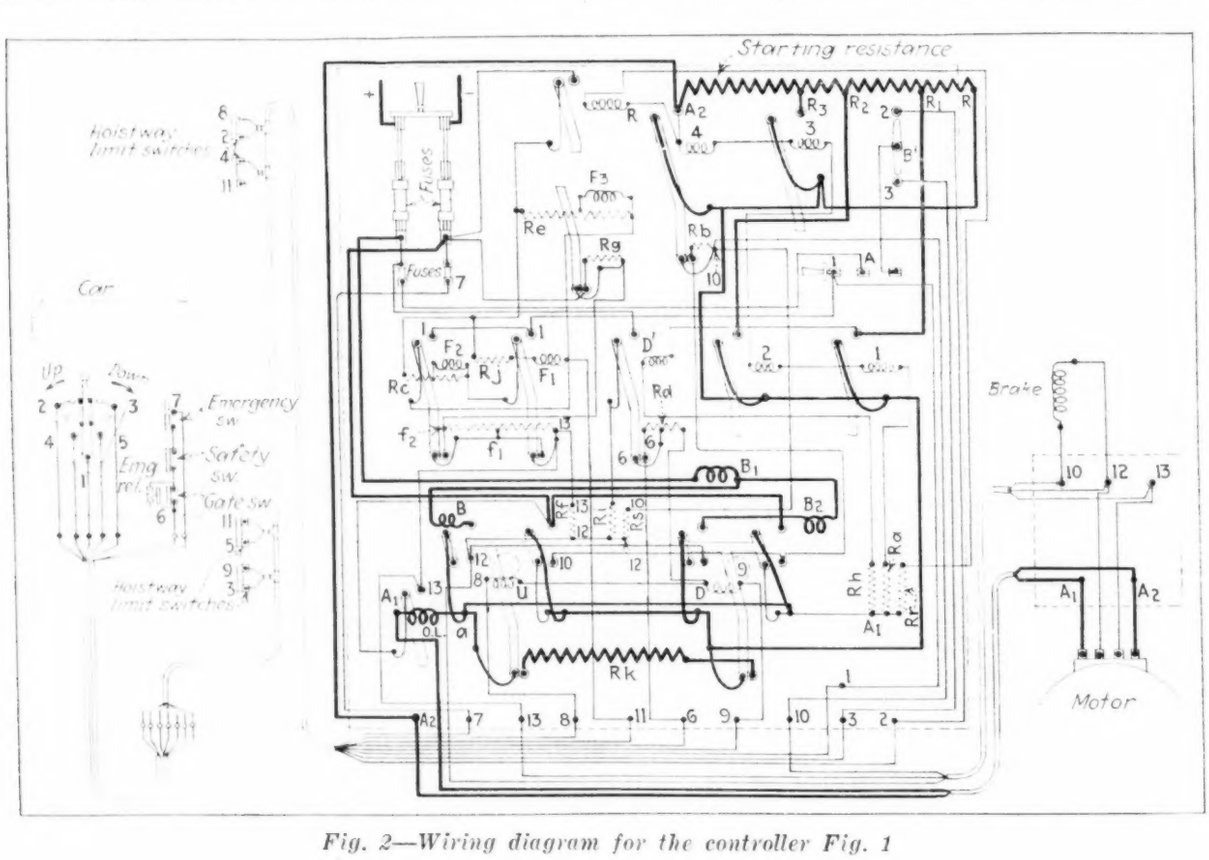


Fig. 2—Wiring diagram for the controller Fig. 1

the armature and causes coil 3 to close its contactor. This latter operation short-circuits the section of starting resistance between R_2 and R_3, which causes the speed of the motor to increase further and contactor 4 to close and connect A_2 on the starting resistance to the right-hand side of the up-direction switch. Therefore the closing of No. 4 contactor cuts all the starting resistance out of circuit, and the motor comes up to speed with the starting resistance cut out of circuit.

When contactor 4 closed, it opened its bottom contact and connected resistance R_h in series with the brake coil and reduced the current in this coil. Resistance R_s is connected from 12 on the left-hand side of the up-direction switch to 10 on resistance R_h. The brake coil also connects to these two points, therefore resistance R_s is in parallel with the brake coil. The function of this resistance is to cause a somewhat smoother application of the brake than would be the case if the coil circuit

were opened when it is disconnected from the line. When the coil is disconnected from the line, its inductance sets up a current through resistance R_s. This current, which exists for a very short period, through the brake coil tends to retard its application and prevents mechanical shocks in stopping the car. Connecting a resistance in parallel with the brake coil also prevents a high voltage being induced in it when disconnected from the line.

A circuit for relay R is provided from the left-hand side of the direction switch through resistance R_r, coil R to A_2 on the starting resistance. With the closing of contactor 4 a circuit is completed from A_2 to the — side of the line for coil R, and this relay closes and establishes a circuit for the field contactors F_1, F_2 and F_3, when the car switch is closed to No. 4 or 5 contacts. Closing the car switch to the high-speed point 4, when relay R is closed, completes the circuit for the coil of field contactor F_1, from 1 on the car switch to 4 and then to 4 and 11 on the top hoistway limit switches back to 11 on the control panel, through coil F_1 and the contact on relay R and to the minus side of the line. When contactor F_1 closes its top contact, it opens its bottom contact. The latter connects the resistance between 13 and f_1 in series with the field coils and causes an increase in speed.

Closing the top contact on switch F_1 completes the circuit for F_2 coil, from the throw-over switch A to the top contact of F_1 through coil F_2 and resistance R_c and to the — side of the line. This will cause F_2 contactor to close and open its bottom contact, which will introduce the section of resistance between f_1 and f_2 into the field circuit, causing a further increase in speed. When the top contact of F_2 closed, it completed the circuit for F_3 coil and caused this contactor to function and open its bottom contact. Opening of the bottom contact of F_3 connected resistance R_g in series with the field coils and the motor now comes up to full speed.

It will be noted from the foregoing that the field resistance has been cut in by three steps. This gives a smoother acceleration than if it were all introduced in one step.

The dynamic-brake contactor D' has its coil connected from the left-hand side of the up-direction switch, through resistance R_h to the top contact of contactor 1. When contactor 1 closes, its top contact is connected to the right-hand side of the up-direction switch and to the — side of the line. Therefore when contactor 1 closes, in addition to cutting out a section of the starting resistance it also connects coil D' directly to the line and it closes its top contact. This provides a circuit for the field coils from the + side of the line to the top contact of relay D', through resistance R_i and through the field coils back to 13 on the controller and to the — side of the line. Consequently, as long as D' remains closed the field coils will be connected to the line through resistance R_i, no matter if the up-direction switch is open. The purpose of this circuit is to retain a magnetizing current in the field coils to cause the armature to produce a dynamic-brake action to assist in stopping the elevator.

Referring to coils F_2 and F_3, it will be seen that they are connected in parallel with part of resistance R_c and R_e respectively, while coil F_1 is connected in series with resistance R_j only. If all the coils were connected alike, the contactors would all open at about the same time and the resistance would be cut out of the field coils in practically one step and cause an abrupt slow-down. The way the coils are connected to their resistances, contactor F_1 will open almost instantaneously when the car switch is moved off the high-speed point. When the coil circuit of F_2 is interrupted by opening the top contact of F_1, the current in the coil will not immediately decrease to zero. Owing to inductance a current will be maintained through the coil and the resistance connected to its terminals. This will cause a short delay in the opening of contactor F_2. A similar delay is caused in opening F_3, so that a gradual slowing down of the motor is obtained when stopping.

When the car switch is centered, the direction switch opens and then through the dynamic-brake action of the motor and the application of the mechanical brake the elevator is stopped. Opening of the up-direction switch connects resistance R_k between the bottom contacts of the two direction switches and completes a circuit for the armature, from A_1 on the motor to the bottom contact of the up-direction switch, through resistance R_k to A_2 on the starting resistance and back to A_2 on the motor. This circuit is on the assumption that contactors 1, 2, 3 and 4 have remained closed. As previously explained, the coils of contactors 1, 2, 3 and 4 are connected across the armature, therefore they will hold their contactors closed until the armature has come down to a slow speed.

Contactor D' holds closed until the motor reaches a slow speed, and in addition to maintaining a current in the field coils for dynamic-braking action, also acts as a non-interference magnet. As long as the bottom contact of D' is open, all the resistance R_d is in series with the coils of the direction switches. Even if the car switch is moved to the on position, sufficient current cannot flow through the direction-switch coil to close it as long as all of R_d is in circuit. Contactor D' is so designed that it will hold closed until the motor has slowed down below where contactors 1 to 4 have opened. This arrangement prevents the operator in the car from suddenly reversing the motor before the starting resist-

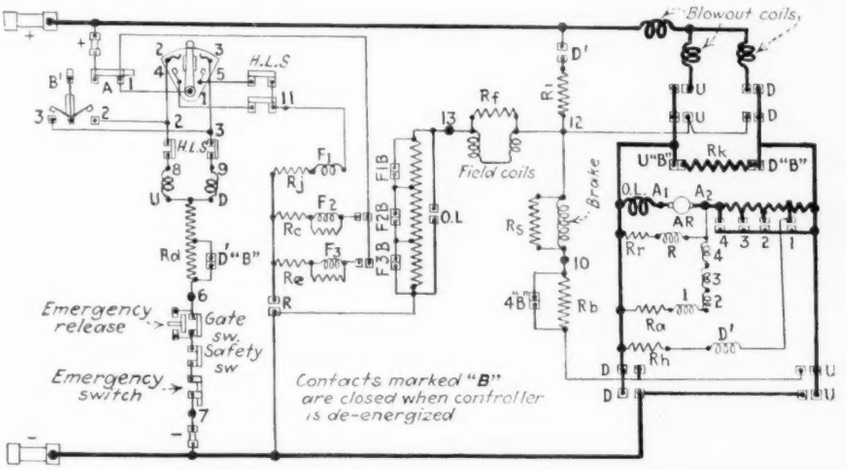


Fig. 3—Simplified diagram of the connections shown in Fig. 2

ance has been cut back in series with the armature.

When the overload relay *OL* is used, if a sustained overload is applied to the elevator, this relay will close and, as previously shown, short-circuit the field resistance. Therefore the motor can be operated at slow speeds only. The closing of this relay on the first inrush of current to the motor insures the motor's having full field at starting.

Resistance R_f is connected from 12 on the up-direction switch to 13 on the field resistance. These two points are the terminals of the field coils, consequently this resistance is connected in parallel with these coils. When inching the car to the floor or during similar movements, relay D' may not have time to close before the direction switch is opened, in which case the field circuit is broken. It is to prevent high voltages being induced in the field coil, under these conditions that resistance R_f is connected across the field coils. When the field circuit is broken, the induced voltage causes a current to flow through resistance R_f and prevents the voltage exceeding normal limits.

When stopping at the terminal landings, the hoistway limit switches function to stop the car similar to centering the car switch. First a cam on the car comes in contact with the first hoistway limit switch and opens it. Opening this switch performs the same function in slowing the car down, as moving the car switch off point 4. Further movement of the car opens the last hoistway limit switch, which has the same effect as centering the car switch, and the car comes to a stop.

In the foregoing the operation of the controller has been considered for only one direction of the car. The reverse motion is the same as the up except that the down-direction switch *D* closes instead of the up-direction switch.

An Automatic Boiler Plant

By H. G. Lykken*

AT NEW PRAGUE, MINN., the International Milling Company operates a 2,500-bbl. per day flour mill and a large grain elevator. The entire power load is carried by a bent-tube boiler having 4,510 sq.ft. of steam-making surface, which is operated at 150 per cent of rating. Originally, the boiler was fired with a chain grate, but early in the past summer this coal-burning equipment was replaced by a direct-firing pulverizer having capacity to supply one ton per hour.

The furnace has air-cooled walls and floor, designed by W. J. Gordon, mechanical superintendent of the International Milling Co., in charge of all the company plants, and W. F. Mullaney, the plant engineer. Mr. Mullaney is responsible for the details of the installation and methods of operation that have made this plant almost unique in power-plant practice.

All the air required for combustion is taken through the boiler walls and through the grinding chamber of the mill. As it enters the mill, the temperature of the air is about 200 deg. F. There are no auxiliary fans, all the work being done by the fan on the mill.

An automatic coal scale supplies the coal to the pulverizer from an overhead bunker. Screening coal is used without preliminary sizing or magnetic separators. An automatic regulator controls the air and coal feed on the pulverizer. The boiler is further equipped with a CO_2 indicator and recorder, feed-water meter and control, steam-pressure recorder, temperature indicators and recorders for the stack gases, feed water, etc.

Makeup water is treated, so that the boiler can be kept on the line longer than is the general practice. No feed-water heater is used, as the plant is equipped with an economizer.

Southern Illinois coal of 11,800 to 12,300 B.t.u. per lb. as fired, is burned, giving an average evaporation of 9.6 to 9.8 lb. Only a small part of the ash remains in the furnace, necessitating cleaning only at intervals of 400 to 500 tons of coal burned.

Remarkably uniform results have been obtained by the use of the automatic regulation. The steam-pressure line is maintained within 2 lb. variation from the mean. CO_2 is maintained at 14 per cent and 24-hour charts are often obtained that do not show over half a point deviation.

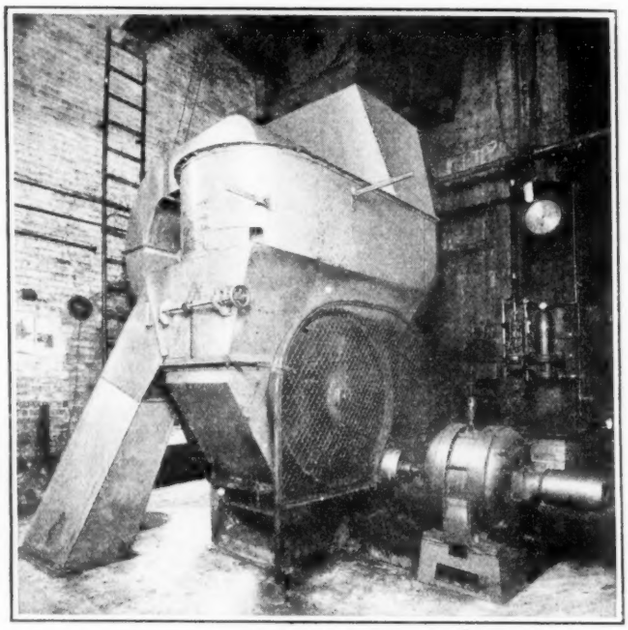


Fig. 1—Direct-firing pulverizer with capacity of one ton per hour

As an addition to the automatic regulation there is automatic coal and water feed, no fires to clean and ash removal once in two weeks; the operation is as nearly automatic as it can be made. The one man on duty in the boiler room is free to take care of other work about the plant and frequently is absent from the boiler room for some length of time. The boiler room is adjacent to the engine room, so that the engineer on duty has full view of the boiler operation, and it is not to be understood that the boiler is left entirely without supervision.

Mr. Mullaney, however, set out to develop an automatic coal-fired plant and has demonstrated that it can be done. He has reduced his boiler-room labor to the minimum and eliminated the fireman altogether. For the fireman he has substituted an operator who has time to do odd jobs, keep the plant in good physical condition and still has time to think, and become a better man.

*Combustion engineer, Unipulvo System.

Doctor Fischer, the German engineer, liquifies coal by first turning it into water gas and then into synthetic wood alcohol.

Testing Forced-Draft Cooling Towers

A Rapid and Simple Method of Telling Whether a Cooling Tower Operating Under One Set of Conditions Meets the Guarantee Made for Another Set of Conditions

By F. W. RABE
Assistant Chief Engineer, Anheuser-Busch, Inc.

SOMETIMES manufacturers of cooling towers make specific guarantees for their towers. For example, a forced-draft cooling tower is guaranteed to cool a given amount of water from a certain initial temperature to a given lower temperature when the temperature of the incoming air and its relative humidity are given. To meet these specifications exactly is next to an impossibility, and the purchaser of the cooling tower may find it difficult to ascertain whether his tower meets guaranteed conditions.

The writer believes he has worked out a simple and practical method for testing forced-draft cooling towers under various conditions of operation and expresses the hope that this may be of help to some of those who wish to find out what their towers are doing. There is nothing particularly new or perhaps even original in this method. It is intended for those who have no time to go into the thermodynamics of air and vapor mixtures and those who have little knowledge of the theory of evaporation.

The function of all cooling towers is to exchange and absorb heat. The amount of heat that can be absorbed depends primarily upon two things—the heat-absorbing capacity of the air and the weight of air circulated per unit of time. The air absorbs heat to raise its temperature and the water supplies the heat of vaporization, while the vapor content of the air is increased as its temperature rises. This causes cooling.

Generally speaking, the heat liberated by the water equals the heat absorbed by the air. This is fundamental. If i_1 and i_2 represent, respectively, the thermal potential of one pound of dry air and the vapor carried by it in the initial and final states, then $i_1 - i_2$ = the heat absorbed per pound of dry air. Also let h_1 and h_2 denote the thermal potential per pound of water in the initial and final states, so that $h_2 - h_1$ = the heat liberated per pound of water circulated. It follows that, for a given time interval, pounds air $\times$ $(i_2 - i_1)$ = pounds water $\times$ $(h_2 - h_1)$.

For a correctly designed cooling tower having good water distribution and no air holes it may be assumed, without appreciable error, that the air leaving the tower is fully saturated; that is, it leaves with 100 per cent relative humidity. For small variations in the fan speed we may say that the volume of air forced through the tower varies as the speed of the fan and the weight of dry air circulated varies inversely as the specific volumes of the dry air plus its vapor content in the initial condition.

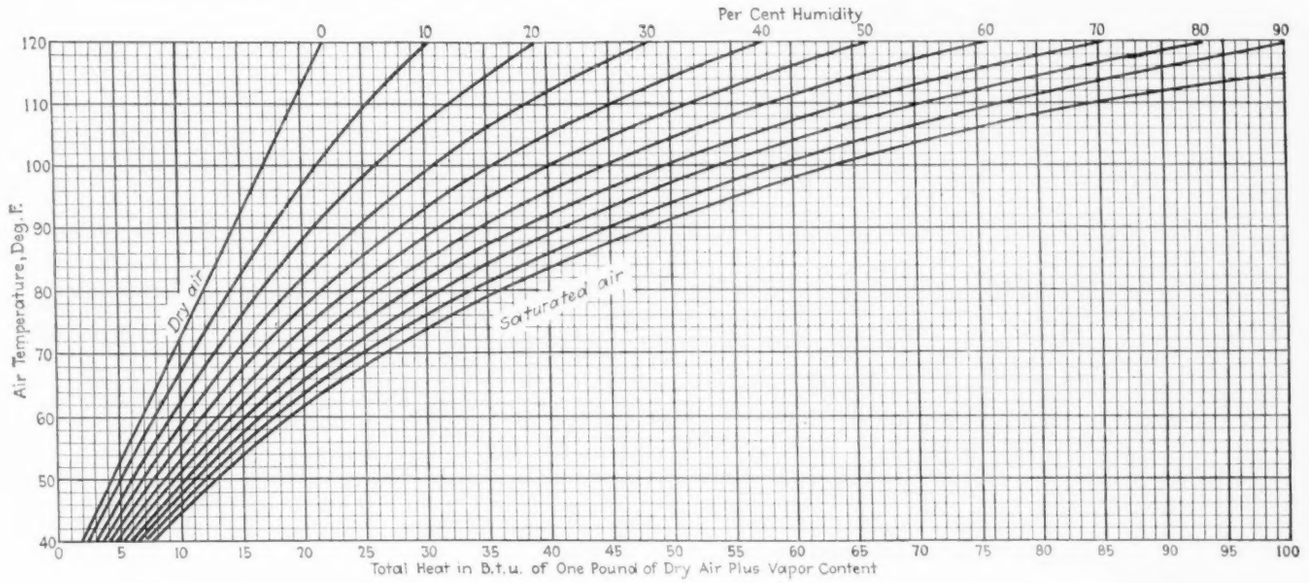


Chart for heat content of one pound of dry air with its moisture for varying temperature and relative humidity

Now suppose a cooling tower is guaranteed to cool M pounds of water per hour[1] from a temperature of t_1 to t_2. The initial and final conditions of the air and the speed of the fan N are given. From these data it is possible to calculate the heat given up by the water, $M(h_2 - h_1)$, the heat absorbed per pound of dry air circulated, $i_2 - i_1$, and the volume V of one pound of dry air plus its vapor content in the initial condition. The same items are determined from test data and will

[1] Pounds per hour = 500 × gallon per minute.

be denoted by primes, $M'(h_2' - h_1')$, N_1', $i_2' - i_1'$ and V'.

$$\frac{i_2' - i_1'}{i_2 - i_1} = C_1; \frac{N'}{N} = C_2; \frac{V}{V'} = C_3.$$

It can readily be seen that when $M(h_2 - h_1) \times C_1 \times C_2 \times C_3$ equals or is less than $M'(h_2' - h_1')$ the cooling tower meets guarantee conditions.

In order to make this test in a satisfactory manner, it is of the utmost importance that all temperature readings be taken with great care. Most of the heat is removed in the upper section of a cooling tower and even distribution of the water is essential to obtain the best results.

The accompanying chart shows the total heat content in B.t.u. above 32 deg. *F.* of one pound of dry air plus its vapor content. The quantity $i_2 - i_1$, for any initial and final condition of the air, can be easily determined in this way.

The following example will make the application clear: A 4,000-gal. forced-draft cooling tower is guaranteed to cool the water from 105 deg. to 85 deg. when the dry-air temperature is 93 deg. and the relative humidity 51 per cent. The temperature of the saturated air leaving the tower is given as 99 deg. and the fan speed as 150 r.p.m.

During a test it is found that the tower cools 3,800 gal. per min. from 95 deg. to 83 deg. The average fan speed is 146 r.p.m., and the temperature of the air leaving the tower is 90 deg. The temperature and the relative humidity of the incoming air are respectively 87 deg. and 50 per cent.

Guarantee Conditions:

$$M(h_2 - h_1) = 4{,}000 \times 500\ (105 - 85)$$
$$= 40{,}000{,}000 \text{ B.t.u.}$$
$$i_2 - i_1 = 28.3 \text{ B.t.u. (from chart)}$$

Test Conditions:

$$M'(h' - h') = 3{,}800 \times 500\ (95 - 83)$$
$$= 22{,}800{,}000 \text{ B.t.u.}$$
$$i_2' - i_1' = 19.5 \text{ B.t.u.}$$
$$C_1 = \frac{19.5}{28.3} = 0.689; \quad C_2 = \frac{146}{150} = 0.974;$$
$$C_3 = \frac{14.32}{14.09} = 1.015.$$
$$M(h_2 - h_1) \times C_1 \times C_2 \times C_3 = 40{,}000{,}000$$
$$\times 0.689 \times 0.974 \times 1.015 = 27{,}200{,}000 \text{ B.t.u.}$$

Since 27,200,000 is neither equal to nor less than 22,800,000, the tower does not meet the guarantee.

The factor C_3 may be neglected without seriously affecting the accuracy of the test. Variations in barometric pressure will also have a slight effect on the performance of the cooling tower, but this factor is not of such importance as to warrant consideration in this case.

CORRECTION—The stokers at the Elyria Iron & Steel Company steam plant were erroneously referred to as "underfeed" in the article on page 598 of the Oct. 19 issue. In reality they are Westinghouse Roney stokers of the overfeed type. It is worth adding that they are used with natural draft.

THE PURPOSE of the steam accumulator is to furnish a "surge tank" for heat, capable of absorbing steam when the pressure rises and of giving it off when the pressure falls.

Effect of Wet Coal on Powdered Coal Firing

BY A. BEMENT

In the development of some of the present equipment offered for powdered-coal firing, an effort is being made to simplify the process of drying the coal. In this respect the drying methods adopted are seldom adequate. The use of coal in powdered form practically began in the cement industry, and its application in this connection was at once successful. It was realized as an initial step in the process that the coal must be dried, and adequate provision was made for that purpose. Drying equipment that accomplished the purpose was rather expensive.

In the first steam plant to use powdered coal successfully, practice in the cement industry was followed and the coal was first passed through driers heated by a coal fire. The successful results with that plant resulted in active interest in powdered-coal firing and the development of a variety of equipments, so that powdered-coal firing is now used extensively.

In an effort to reduce first cost and expense of operation, simple methods of drying have been exploited, such as heated air in the mill or the use of a chamber through which the coal moves to be dried either by heated air from hollow furnace walls or by waste chimney gases. It appears, however, that fine coal when wet, as it may be at any time, sticks in certain types of driers and fails to move. The result of these conditions is that some manufacturers advocate the use of large coal to insure its proper movement. This is certainly an illogical situation, in view of the fact that there is an important supply of fine coal to be had at a more favorable price than 1¼-, 2-in. or larger sizes command. For example, Illinois produces a large quantity of ¾-in. coal, which usually sells at 30c. a ton less than 1¼-in. and 40c. less than 2-in. screenings.

Considering the first cost of powdered-coal burning equipment, it would appear that one of the important justifications for its use would be ability to burn cheap fuel, and as the coal is burned as powder, it would seem logical that material already largely in form of powder should be used, especially when its cost is much less than superior grades. For this to be made possible with certain systems, the drying proposition must be given serious attention if one of the most important advantages in the use of powdered coal is to be secured and advantage taken of the important "talking point" of cheap coal, that was so effective in making a market for the mechanical stoker.

A SERIES OF TESTS conducted on renewable and one-time inclosed cartridge fuses indicated that the rupturing capacity of the fuse is largely a function of the length of the fuse element and the volume of the cartridge fuse case. The time of interrupting a circuit was found to be very selective between fuses of different sizes. The melting time of the fuse was a direct function of the thermal capacity of the element and inversely to the heating effect of the short-circuit current.

FOR LOW-VOLATILE COAL and 10 per cent of CO_2 1 per cent of CO in the flue gas represents a loss of about 7 per cent of the fuel.

Mixed Types of Equipment May Be Justified

VISITORS to power stations are often amazed at the lack of uniformity in types of equipment installed—not so much as between different plants, but in the same plant. This is especially true in some of the larger stations, where the essential complexity is increased by different makes of prime movers, condensers, methods of control and a multiplicity of auxiliary types. The first impression is that this must lead to confusion in operation, especially during the breaking-in period and in times of emergency; also that it adds to the maintenance problem by necessitating a greater stock of spares.

Obviously, if it were possible for the designing engineers to choose, with certainty, the ideal equipment to suit the requirements, the greatest flexibility and ease of operation would be assured. But designers are not infallible, and development of equipment is progressing at such a pace that no one is in a position to judge as to the relative merits of different types without actual trial. In fact, a certain degree of experimentation in plant layout is a mark of progress. In this connection it may well be that the information gained through comparative performances will offset a certain amount of inconvenience in operation and lead to greater economies in subsequent extensions.

There is still another justifiable reason for mixed types. In the construction of some large stations the equipment orders are so large as to overtax the capacities of certain manufacturers. Delivery dates are important, and the spreading of contracts is an insurance against delay in meeting construction schedules.

For these reasons it is well for one to reserve judgment when visiting any new station until all the factors are known.

Smoke Abatement Is Reviving

BEFORE the War substantial progress was made in the elimination of smoke in the larger cities. Then came a period of market disturbances that made it impossible to apply stringent rules to the selection and use of fuel, and smoke abatement was forgotten.

During the last two or three years activity has been resumed. There is increasing attention to the subject. At the recent International Conference on Bituminous Coal in Pittsburgh an entire session was devoted to the subject, and at the A.S.M.E. annual meeting this week a similar provision has been made. Again the engineer is taking his place of leadership in this important undertaking.

Industrial plants that burn large quantities of fuel can be enlisted in the smoke abatement work through the consideration of savings in their fuel bills. Householders, apartments and other small users, on the contrary, must be approached in other ways. With their ordinary equipment they cannot burn bituminous coal smokelessly, and it seems infeasible at present to require the installation of equipment that would cost several times the fuel bill for an entire year. The remedy in this field seems to lie in the substitution of smokeless fuels for those now commonly burned in many sections of the country. This is an elaborate undertaking, involving the development of commercial processes for the production of such fuels, as well as the task of persuading the user to buy them and teaching him how to burn them in the cases where special technique is required.

The task is to a large extent educational, using that term in a broad sense to include the art of persuading people to change their traditional methods of doing things. And the work cannot be done by a few paid men. Every engineer must enlist in support of the cause and, by example and precept, show his friends and neighbors how to clear up the atmosphere of our cities. They need it.

Safety Regulations for Pulverized-Coal Installations

THE proposed code of safety rules for pulverized-fuel systems, which is printed on another page of this issue, should receive the close attention of all engineers in the power field, and comments should be sent to H. E. Newell, Secretary of the Subcommittee on Powdered Coal, of the National Fire Protection Association, 85 John Street, New York City, before December 15.

Fire insurance companies naturally safeguard themselves to the utmost degree in the adoption of measures of this nature, and considerations of public safety lead to the adoption of similar requirements by various governmental units. It is important that the engineer point out in advance any features that seem to him unnecessarily restrictive or irrelevant to the cause of safety.

The basic essential underlying all these rules is that the formation of an explosive mixture of coal dust and air must be prevented at all costs and that, if such a mixture should form, it must be confined in a limited space, with ample relieving area in the shape of loose panels or thin glass windows, and cut off from access to other plant equipment.

Now it may be argued that when equipment is well constructed, with joints made water-tight by welding, there can be no dust leaks, and hence that it is unduly severe to require the same degree of isolation that should be demanded for a system not thoroughly dust-tight. It may be said that the prime object is safety, and that whether this is attained by doing a first-class job of construction or by isolating a second-rate job in a bomb-proof shelter is a secondary question.

The reply to this type of argument is that in the

formulation of safety rules it is necessary to set up requirements such that conformity to a degree easily checked by inspection will be certain to effect the desired degree of safety. It is difficult, if not impossible, to determine by any simple single inspection whether a pulverized-coal system is dust-tight. It is easy to tell whether walls and firedoors and window areas and the like are adequate to confine and relieve explosion pressures. Do such requirements impose an extra burden on the man who does high-grade work in setting up his equipment? Yes, probably they do, although in most plants the isolation of the pulverizing machinery is justified on the basis of operating convenience. But, granting this additional burden on the good job, can the regulations therefore be relaxed? By no means. Rules of this type always impose onerous restrictions on the first-class worker, because they must provide minimum requirements that will produce the necessary safety in the case of even the worst workmanship.

The formulation of rules of this sort is a prodigious task, and no body of men can hope to foresee every contingency. It is important that any engineer concerned with power-plant operation should give the National Fire Protection Association the benefit of his comments. It is much easier to modify this material now than it will be after its formal adoption.

Another Report on St. Lawrence Development

FOR many years the development of the St. Lawrence River for power and navigation has been an issue before the people of this country and Canada. The latest chapter in a plan of development is the recent report of the Joint Board of Engineers on the St. Lawrence Waterway Project, published in last week's issue. Although the recommendations in this report coincide with the general ideas expressed in the report made to the International Joint Commission in 1921, it is much more comprehensive and involves a considerably larger power development.

The project, as now visualized, embraces the development of the river to provide a twenty-five foot channel for navigation and the installation ultimately of over five million horsepower of hydro-electric machinery at an estimated cost of six hundred and fifty million dollars. This power exceeds the total capacity now installed in central stations in New York State and is greater by about twenty-five per cent than the total developed water power in Canada.

Many obstacles must be cleared away before development can begin on this project. About fifty per cent of the proposed power development is on the international section of the river, necessitating an agreement among four governments, and if the total river be included, five such bodies are involved. Such agreements, if the past is a criterion, are usually arrived at only by a very slow process. Although large blocks of this power could be economically absorbed in New York State and New England, Canada has no immediate use for it. On the Ottawa River and its tributaries, within transmission distance of the districts in which St. Lawrence power will be distributed, there is over one and one-half million horsepower, only a small part of which has been developed. This power can be produced in comparatively small blocks, at low cost. The financial outlay in each of these projects is small, compared to any one of the developments on the St. Lawrence. Everything considered, it is natural for Canada to take the course of least resistance.

On the navigation end of the project there is much opposition. New York State has her own pet scheme of connecting the Atlantic Ocean with the Great Lakes, by a ship canal. Canada has her advocates for connecting Montreal with the north shore of Lake Huron by way of the Ottawa River and Georgian Bay. Then there are Lake cities that are alarmed about what may happen to them if the St. Lawrence becomes a waterway suitable for oceangoing boats. It is therefore evident that the initiation of actual construction on a comprehensive plan for development of the St. Lawrence will probably be delayed for some time, no matter how strong influences may be to get the project under way. Notwithstanding these handicaps the reports of the joint commission have shown that the engineering and economic phases of the project are sound and are fairly well agreed upon by the different engineering bodies and have no insurmountable difficulties.

Why Questions Are Asked

ALMOST daily, subscribers of *Power* write in, asking the way to set the valves of some particular make of engine, to level a piece of machinery or to prevent an oil engine from preigniting.

While all questions are gladly answered by an editor who is acquainted with the subject, the thought occurs as to why the engineer who is confronted with such a perplexity does not turn directly to the manufacturer of the apparatus. While every steam engine functions along well-understood lines, each make has some particular characteristic that is not possessed by another make. In fact, in many instances each engine put out by the builder has enough variation from the previous one to make any general statement as to the details of adjustment inapplicable to the engine in question. Consequently, the persons who are able to give most accurate information as to these details are the builder and the operating engineer who receives an instruction book when the unit is turned over to his care. There are, of course, many instances where the machine builder is no longer in business and factory information is not available.

The mystery is, why does not this operating engineer make use of the information in the instruction book, excluding, of course, those instances where the engineer's predecessor has carried it off as personal property? The solution was sought of a well-informed engineer, who as a reply produced a well-bound instruction book issued by the builder of a steam turbine. A perusal of a few pages was sufficient to answer the conundrum. Probably all the data a man would ever need to adjust, repair or even build a turbine was contained between the book covers, but the statements were abstruse. Sentences began nowhere and ended in vagueness; some began clearly and boldly, but ended in a congestion of qualifying phrases and subordinate clauses sufficient to give a brainstorm to the most erudite. No wonder the bewildered engineer turns elsewhere for help.

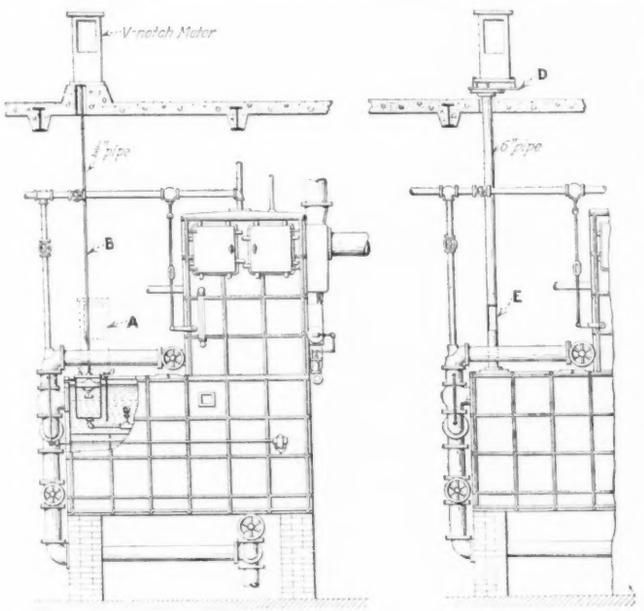
Such instruction books serve no useful purpose. Instead, there is likely to be a positive ill effect. Any one reading such bewildering pages cannot help feeling that the builder has given him affront—even more, he suspects that someone is hiding ignorance behind a mass of words.

Practical Ideas From Practical Men

Removing Vibration from the V-Notch Meter

When we extended our power plant about a year ago, we installed a 200,000-lb. open-type heater equipped with a V-notch integrating and recording meter. In order to make the meter more accessible for reading and for any adjustment that might be necessary, we placed it on a concrete block on the turbine floor instead of leaving it on top of the float chamber of the heater, as indicated by the dotted lines at *A*. This change necessitated extending the float rod *B* and compensating for the additional weight on the float.

This arrangement, however, did not turn out as well as we had expected owing to excessive vibration imparted to the meter through the floor from the turbines. The meter was close to a 2,000-kw. machine that ran "rough" and vibrated rather excessively at the critical speed when being brought up to speed or slowing down. The vibration at normal operating was sufficient to make the small friction wheel of the integrating mechanism chatter constantly on the large driving disk, and at the critical speed of the turbine rotor the meter would for some reason run backward, sometimes as much as 40,000 to 50,000 lb. Consequently the readings were far from accurate.



Change made in meter foundation to overcome vibration

To overcome this trouble, we decided to support the meter from the heater and make it independent of the turbine floor. This was done by means of a 6-in. pipe having standard flanges at each end. The pipe was bolted, at the lower end, to the cover of the float chamber, and at the upper end a piece of boiler plate *D* was interposed between the pipe flange and the meter. An opening about 9 in. long was made in the pipe at *E* to permit of connecting the float rod and the extension to the meter, and for future adjustments.

This new foundation freed the meter from all vibration and completely removed the trouble from faulty readings.

New York City. L. A. COLEMAN.

Wants High-Speed Steam Engines

A very wide field has been opened up for the generation of cheap power in industrial plants by the recent development of new types of prime movers. One of the latest is a compound reciprocating engine taking steam at 350 lb. pressure and 700 deg. and exhausting at 5 lb. back pressure to a process requiring low-pressure steam. A water rate of 11.5 lb. per hp. was obtained, corresponding to 83 per cent engine efficiency (Rankine Cycle), while similar efficiencies have been obtained with uniflow engines under similar conditions.

The efficiency of medium-capacity turbines operating over the same pressure range is not over 55 per cent, which clearly indicates that the reciprocating engine is better adapted for back-pressure conditions where the oil content of the exhaust is not objectionable.

In view of the high efficiency, why is the engine not preferred to a turbine? The answer lies in the selling price of the two units. The lower investment and fixed charges often swing the decision in favor of the unit with the lower efficiency.

As there is not much possibility of raising the efficiency of non-condensing engines above 85 per cent, the only chance the reciprocating unit builders have to compete with turbines or with purchased current is to reduce construction costs, while increasing the pressure and temperature range.

To do this, radical departures from conventional practice will be necessary. A slight reduction in efficiency is permissible if costs can be reduced to a point where there is a total saving. It has always been assumed that piston speeds of 800 ft. per min. are the maximum allowable for steam engines to prevent vibration and lubrication troubles. But automobile engines have attained speeds of 1,500 ft. per min., yet they are successfully lubricated. Pressures and temperatures in these engines are far beyond anything attempted in steam-engine design and they are far more complicated. The problem of cylinder lubrication in high-speed uniflows has been simplified by placing the cylinders in a vertical position. The operation of such engines at piston speeds of 1,500 ft. per min., with pressure up to 500 lb. is by no means impossible or impracticable.

Multi-cylinder construction is of course necessary under such conditions, and for satisfactory lubrication we may have to copy the method used in internal-combustion engines. Multi-ported piston valves might function more satisfactorily than poppet valves under these conditions, and if the temperature of the steam

striking the valve is above 800 deg. F., it might be advisable to have the valve partly water-cooled. All these changes are not to be lightly undertaken, as there is a vast amount of development work involved, but in view of the possible gain to be made, the problem deserves considerable study and discussion. Not the least of the difficulties to be overcome is the inertia of the manufacturers.

A good non-condensing engine uses 18 to 20 lb. of steam per indicated horsepower-hour at ordinary pressures even though the efficiency for the pressure range used may approach 80 per cent. It is possible by starting at 1,500 lb. and 800 deg., using the regenerative cycle with a compound engine, to reduce this steam rate to 6 lb. per indicated horsepower-hour. Reduction of operating costs with also a reduction in the cost of power units is a worth-while mark to shoot at and is sound on both engineering and economic grounds.

A uniflow engine recently installed cost around $40 per hp. f.o.b. factory and operated at a piston speed of 700 ft. per min. If the speed of this unit could be safely doubled without altering other conditions, the initial cost per horsepower would then be cut in half. The initial steam pressure is 135 lb. and back pressure 2 lb. If steam enters the cylinder at 300 lb. instead of 135 lb., the capacity is doubled, as over twice as much steam can be passed through the engine due to reduction of volume, but the efficiency is reduced due to incomplete expansion. As the capacity is quadrupled by doubling the speed and increasing the pressure and steam flow, the cost per horsepower is reduced from $40 to $10, assuming that no obstacles lie in the way of increasing the speed and pressure.

Springfield, Mass. ANDREW SHEEHAN.

Overcoming Pump Troubles

We were forced to make a quick repair on one of our boiler-feed pumps, the water end having cracked across the cap covering the discharge-valve deck. The crack was in the center running out within three inches of the edge. We were miles from any welding shop or supply house, and our reserve pump was hardly large enough for continuous duty.

Holes were drilled and tapped for pipe plugs at each end of the crack to prevent it extending farther, and then four holes were drilled on each side of the crack and tapped for $\frac{5}{8}$-in. capscrews. The crack was just eight inches long, so we cut four strips of steel three inches long from 1x$\frac{1}{2}$-in. stock. The center-to-center distance across the crack between the holes in the cap was two inches, and we then heated the steel strips before laying off the bolt holes with the same center-to-center measure. While being drilled, the pieces cooled off and it was necessary to reheat them before the holes came in line with the holes in the cap. A thin red-lead mixture was poured into the crack and the steel strips bolted on while hot. After cooling, they shrunk enough to pull the crack together.

Although the repair held against the discharge pressure, we ordered a new cap at once as we did not know how much load the shrinking process had put on the capscrews or the strips.

We also had a motor-driven brine pump used for circulating brine at 45-lb. pressure, but used only as a spare, the main being a triplex plunger unit. The centrifugal was used for week-end service to allow time to overhaul the main pump. Often, when starting, the fuses would blow on this pump, and this happened the first time I had occasion to start it. As the circuit was fused as heavily as consistent with safety, I looked around for the trouble instead of accepting it as a necessary evil as other operators had done. I found that there was no suction valve on the pump and the discharge was located out near the main line. This valve had an extension stem running up through the floor to permit opening it from the operating floor. The man assigned to read temperatures through the cold-storage rooms had opened this valve.

I went in to look at the pump and noticed that it was revolving in the opposite direction from that indicated by the piping connections. After the discharge valve was closed, the pump came to a stop and we found that starting with the discharge valve closed was accomplished without difficulty.

The next time the pumps were changed over, I stood near the centrifugal unit while the oiler pulled the switch. The pump stopped in a few seconds and then started to revolve at full speed in the opposite direction. The pressure of the brine caused it to back up through the pump and flow into the tank directly beneath, and was responsible for the reversal of rotation, also for the heavy starting current required.

A near-by engineer asked me to look at his feed pump on my way home one night, and when I stopped there, the pump was running quietly. But as soon as he opened the throttle more and the pump came up to the speed maintained in the day run, it became noisy. A heavy thump at each end of the stroke began as soon as the speed was brought up to normal, and when the speed was reduced the noise disappeared. The pump was a duplex and the noise seemed to be in one steam cylinder only. I pulled the rod on that side, and while doing it I learned from the engineer that the rod had been taken out a few weeks previously, when a new piston was put in. He produced the old piston, which I found was fractured at the taper. Comparing the two, the new one was $\frac{1}{4}$ in. shorter than the original, which suggested the cause of the pound.

The shorter piston increased the clearance and consequently reduced the compression. At low speed the pressure in the cylinder was not high enough to necessitate much compression, but at higher speed the steam pressure increased and compression was necessary to insure quiet operation. The rod was placed in the lathe and the taper was filed to permit driving the piston on farther. A piece of $\frac{1}{16}$-in. plate was the nearest we could find for our purpose, and from this we made a plate to fit on the rod against the piston, bringing the thickness up to that of the original piston. After assembly, the pump ran quietly at the required speed.

Thompsonville, Conn. G. H. HART.

MERCURY-ARC RECTIFIERS are in operation supplying a 4,000-volt direct-current railway system. This type of rectifier has been operated experimentally at 10,000 volts, and there is apparently no theoretical limit, provided the proper temperature can be maintained. As to space requirements the mercury-arc rectifier is at a disadvantage when compared with rotating equipment of the same voltage for 600-volt service and less. At 1,500 volts and higher the arc rectifier will probably require less space than rotating equipment of the same capacity.

Comments from Readers

Why Is the Vacuum Low?

In answer to A. W. Napier's inquiry in the Nov. 16 issue, as to why the vacuum was low, I wish to state that I once had similar trouble.

As we all know, low vacuum is usually caused by air leaks around the condenser connections or insufficient circulating water. According to his readings I would say that there is too large a temperature difference between his circulating-water intake and the discharge water. I think that if he will overhaul the circulating pump and carefully examine the pump impeller seal rings or guide rings for wear, he will be able to overcome the trouble. From the readings it looks as if the circulating pump was not doing its work.

Scranton, Pa. ELLIOTT E. SMITH.

Burning Lignite

In the issue of April 20 there was a very interesting article on lignite coals by Oscar B. Berg. I should like to relate some of the experiments that we have made along the same lines. In Winnipeg we are at a considerable distance from any of the coal mines, and freight charges are heavy on any of the recognized steam coals. The nearest high-grade steam coal on the Canadian side is mined in the Alberta and British Columbia fields. Coal from the United States, which is usually a better grade, can be purchased as cheap as, if not cheaper than, the Canadian fuel. We have, however, a fuel similar to the Dakota lignite, which costs around $4 a ton delivered.

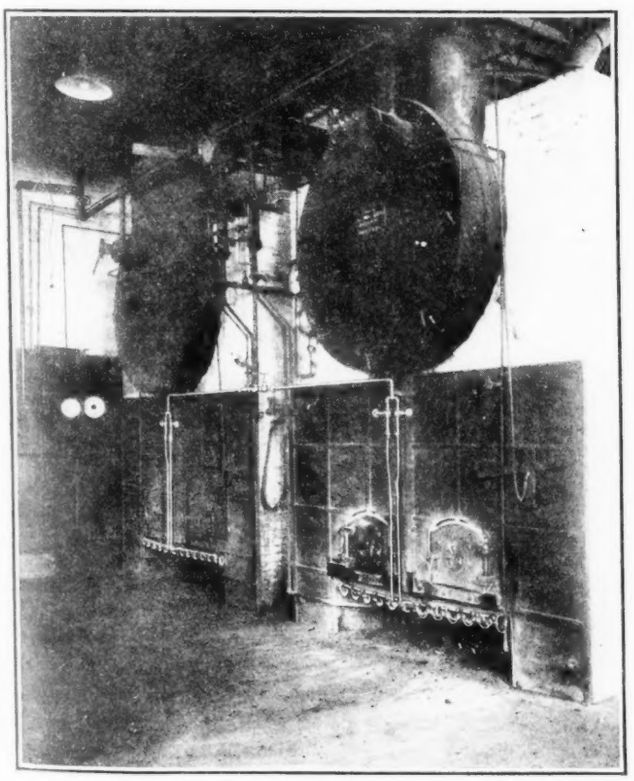


Fig. 1—Boilers equipped with turbine grates

Being compelled to change our equipment on account of the age of the boilers, it was decided to install boilers and furnaces that would burn the lignite mined in the Souris field. A hand-fired installation installed in the

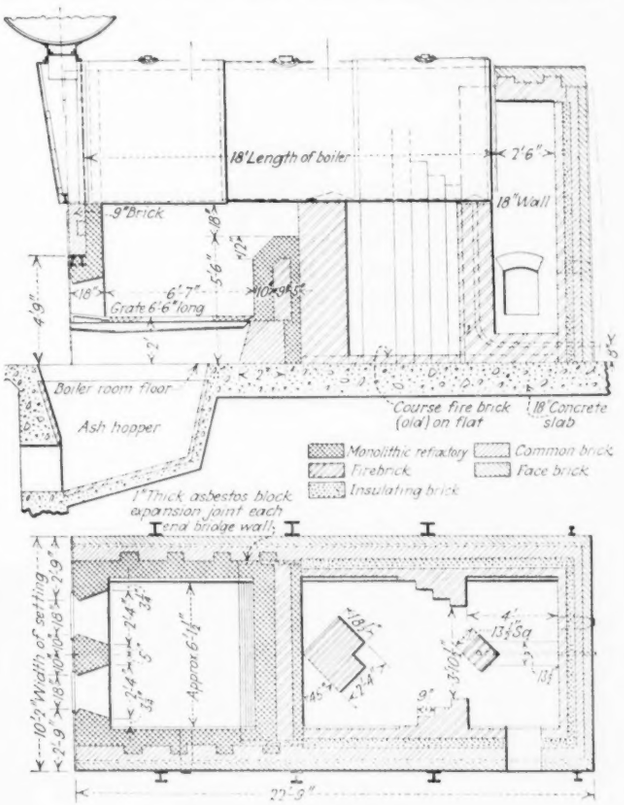


Fig. 2—Boiler setting to burn lignite

C. P. R. roundhouse, however, had been burning almost anything that had any combustible matter in it, and having had an opportunity to follow this plant since its installation, a similar proposition was recommended and later installed in Drewry's Brewery.

The old boiler equipment consisted of five 800-sq.ft. horizontal-tubular boilers, which supplied steam for brewing, pasteurizing, and driving steam engines direct-connected to ammonia compressors. These boilers, one of which had been in operation 26 years, were set about 27 in. above the grates, and at times four boilers would be on the line together.

The new equipment consists of two 1,500-sq.ft. return-tubular boilers fitted with turbine furnaces. Feedwater regulators, soot blowers, draft gages to each boiler and a recording draft gage with a CO_2 recorder piped so as to be used with either or both boilers were also included in the list of new apparatus.

The boilers were built for a pressure of 150 lb. and were set 5 ft. 2 in. above the turbine-furnace grate bars. This furnace is manufactured in England and consists of 12 troughs to each boiler. The troughs are 6 in. wide and 6 ft. long, and the fire bars are placed crosswise. Running under the deadplate, the troughs are fitted with Venturi throats at the ends of which are ¼-in steam jets. No air can get to the fires without passing through the Venturi throats, and an equal pressure of air is evenly distributed under the whole furnace. Steam pressure of 30 to 40 lb. is supplied to the steam nozzles, and to obtain the best results only 0.15 in. of draft is carried over the fires.

Since these boilers have been in operation all kinds of fuels have been experimented with, and the only trouble encountered has been with coals high in volatile. This could be easily overcome, however, by putting in an ignition arch.

The settings, Fig. 2, are arranged so that the gases are held as long as possible within the setting in order that the heat may be given to the boiler. Immediately behind the bridge wall a square pillar is erected with its points running lengthways with the boiler. This pillar is extended up to and shaped to part of the boiler shell, allowance, of course, being made for expansion. The walls are brought in toward the center and stepped so as to offer still more resistance to the gases, and finally, before the gases enter the tubes, they are again spread by another square column which also serves as a protection to the blowoff pipe.

In the operation of these boilers with 0.15-in. draft the air is practically balanced, and although hand-fired, there is little loss through the doors, and as much as 45 lb. of lignite coal per hour has been burned per square foot of grate surface.

The lignite has been used exclusively for several months with excellent results. The only drawback to Souris slack is that as it is 6,900-B.t.u. coal, it requires quite a lot of shoveling. We have been able to burn screenings and other accumulations from different coal-yards without the usual clinkering difficulty which had been experienced on former occasions with the old grate bars.

One remarkable feature about this installation is the fact that as good average of CO_2 can be maintained as with any mechanical installation. An average of 14 per cent can be obtained any time the boilers are in any way loaded.

Tests have also been made mining various coals. The plant at North Dakota mixed lignite with Splint and Youghiogheny. Both the latter coals are high in volatile and, as already mentioned, such coals would give us a certain amount of smoke trouble. We have not mixed along those lines, but we have used a combination of anthracite screenings, coke breeze, and some of the subbituminous coals from Alberta.

Our load here varies quite a lot, and we never have any warning as to when a load will be put on. The big demand for steam, however, lasts only between the hours of 7 a.m. and 5 p.m. The load for the rest of the 24 hours is just heating water for the next day's brew or heating buildings. Steam is not required any more because the ammonia compressor is now motor-driven, provision, however, being still made for breakdown in the electric supply by keeping a steam-driven compressor.

A few of the tests made three days in succession show the results that are obtained. The first was made with lignite with the following analysis: Moisture, 33.5 per cent; volatile matter, 26.6 per cent; fixed carbon, 31.4 per cent; ash, 8.5 per cent; B.t.u. per lb., 6,970. The second was made with Pocahontas slack with analysis of: Moisture, 4 per cent; volatile matter, 18.3 per cent; fixed carbon, 70.7 per cent; ash, 7 per cent; B.t.u., 14,050.

The first test results were as follows:

Duration of Test, hours	10
Coal used	Souris slack (Lignite)
Cost per ton	$4.25
Amount used, lb.	16,400
Cost of coal for test	$34.85
Steam generated, lb.	76,590
Cost of coal per 1,000 lb.	$0.455
Pounds of steam per lb. of coal	4.67

The second test:

Duration of Test, hours	10
Coal used	Pocahontas slack
Amount used, lb.	6,000
Cost per ton	$8.50
Cost per test	$25.50
Steam generated, lb.	60,840
Cost per 1,000 lb.	$0.419
Pounds of steam per lb. of coal	10.14

The third test, which was run with a mixture of equal weight of Souris Lignite and Pocohontas screenings resulted as follows:

Duration of Test, hours	10
Amount used, lb.	8,200
Cost of coal for test	$26.15
Steam generated, lb.	69,750
Cost of 1,000 lb. steam	$0.375
Pounds of steam per lb. of coal	8.5

While these 10-hr. tests show what is being done each day, the owner may not be particularly interested in it, but at the end of the month, if the coal bill is less, he probably will appreciate it. A. E. HAYNES.

Winnipeg, Canada.

When the Engineer Buys Equipment

The communication of Frank V. Faulhaber in the issue of Nov. 9 deals with a subject of considerable importance.

I quite agree that those who are responsible for the purchase of mechanical equipment should give every possible consideration to new devices which appear to have points of merit. At the same time we must not overlook the fact that only time and experience will prove whether a new piece of equipment is as good or better than one of an older type that has been in use for a long time and found satisfactory.

The more experience I get, the more I am convinced that taking a gamble in the hope of getting the very best of everything is much like playing the stock market for peak prices. As a rule it cannot be done, and moreover, I am becoming every day more sure that with few exceptions, I do not actually know what is really the best in any line. I hope that no one will feel insulted if I add that nobody does.

The fact is that in almost every line there are many makes that have a number of satisfied users, some of whom would be only too glad of an opportunity to affirm that the apparatus they are using is the best on the market. There is not the slightest difficulty in collecting evidence of this kind relative to any piece of standard equipment, and I claim no exemption for myself, but I know that when I believe that a certain piece of equipment is the best of its kind, I am probably kidding myself.

If we really set out in a fair and scientific manner to

discover which is actually the best of a number of competing articles, we find that it calls for greater time and facilities than are available to most of us, and even if they were, each investigator would probably come to a somewhat different conclusion. Fortunately, in spite of these handicaps, experience enables many of us to develop a list of materials and methods which either from our own experience or our knowledge of the experience of others, we know to be reliable and certain to give satisfactory results. Indeed, to a large extent it is this knowledge that enables the experienced man to give a quality of service that cannot be equaled by one of less experience.

If, when a job is done, I can feel sure that every piece of equipment that went into it is reasonably efficient and reliable, I am satisfied. I do not ask that it shall be absolutly the best of its kind, because I know it is foolish to ask for the impossible.

When we buy equipment, we do, or should, buy service, and that includes not only a well-designed piece of apparatus, but the reliabilities and reputation of the manufacturer. If a manufacturer has established these, it is both sound ethics and sound business to give the fullest weight to them when making our decision.

On the other hand, it is true that refusal to give consideration to new types is too often due to laziness or lack of the courage necessary to form an independent opinion and stand back of it, in which case I heartily endorse Mr. Faulhaber's criticisms. At the same time we must not overlook the fact that when we purchase a piece of equipment that has not been thoroughly tried out for a considerable time in actual service, we are taking something of a gamble, and generally with someone else's money, so that we are under a strict obligation to assure ourselves that the risk is justified; and if we have not the time and facilities for doing this, and in many cases we have not, it is quetionable whether we should take any chances.

Newark, N. J. JAMES O. G. GIBBONS.

Methods of Solving the Great Fuel Problem

When we consider that the world is still wasting about half of the coal mined, and that smoke abatement is far from being accomplished, we must admit that there is "a great coal problem" that has not been entirely solved.

Coincident with the present writing,[1] the International Conference on Bituminous Coal is in session, bringing out information that will probably comprise about all that is generally known to the world of matters pertinent to this subject. But if the researches of the United States Patent Office as to disclosures recorded prior to the last anthracite strike are conclusive, I have something that is new to add to the symposium and I think it is of value and pertinent to the general subjects of smoke abatement and fuel conservation.

The most practical solution of the great coal problem, in my opinion, would be to give *all crude fuels* such preburning preparation as will enable them to be changed into such converted form as to make their handling a simple matter to the rank and file of fuel users. The basis of my idea has been to produce low-cost fuel gas from the lowest-cost fuel materials.

The soft coals, as is generally known, vary in their volatile content from 12 per cent to 40 per cent or more, and they cost, especially those having high volatile content, much less than anthracite. But these cheaper rich fuels, in their burning, swell, crumble and melt and hence clog the porosities of the fuel mass more or less and result in clinkers and other changes which disturb the uniformity of texture of the fuel mass. The result is an enormous waste in their burning, as well as the smoke nuisance.

The simple ideas which have come to me, and which apparently I have been the first to evolve, have been so to carbonize the too soft and hence richer coals, as to harden them and prevent their crumbling in their burning and under low-, medium- or high-temperature carbonizations according to the character of the cokes desired. Another step is the enrichment of the coked product with such various specific amounts of solid fuel matters as will somewhat decrease the porosity of the coke mass. Again, the coke may be enriched by impregnation with low-cost fuel oils. Such enriching oils may be secured by the distillation of bituminous and lignite deposits or by the petroleum fractionates so long as that supply holds out.

Accompanying these steps is the other step of utilizing the volatile distilled from the coals in their hardening, to make fuel gas, in connection with water gas or producer gas, from the waste heat of the process. Such gases can be enriched by the oil impregnant of the cokes. The high-temperature coke can be used in a cycle through their cooling with steam regeneratively produced in the process.

The principle of the low-temperature carbonization of coals can be applied in the production of steam in a circuitous method where mixtures of coke and lowest-cost high-volatile bituminous coals or lignites can be used at a large saving in the primary cost of fuel as compared with the present-day cost of popular steam coals. J. M. W. KITCHEN.

East Orange, N. J.

[1] Mr. Kitchen's comments were received Nov. 16, during the Conference, and have been somewhat abridged.—Editor.

Estimating the Blowdown

Referring to the article by J. D. Jenkins in the Oct. 26 issue on "Estimating the Blowdown," he did not mention the important point that to be as accurate as possible the steam pressure should be the same at the end of the blowdown as at the beginning. If there is any difference in the steam pressure, the water level will be affected and the figures used in the computations will not be correct.

It is a well-known fact that as soon as the steam pressure in a boiler drops, the water level will rise even though no water has been added to the boiler. And, inversely, when the steam pressure increases, even though water may be continually added to the boiler at a rate greater than the steam consumption, the water level may drop.

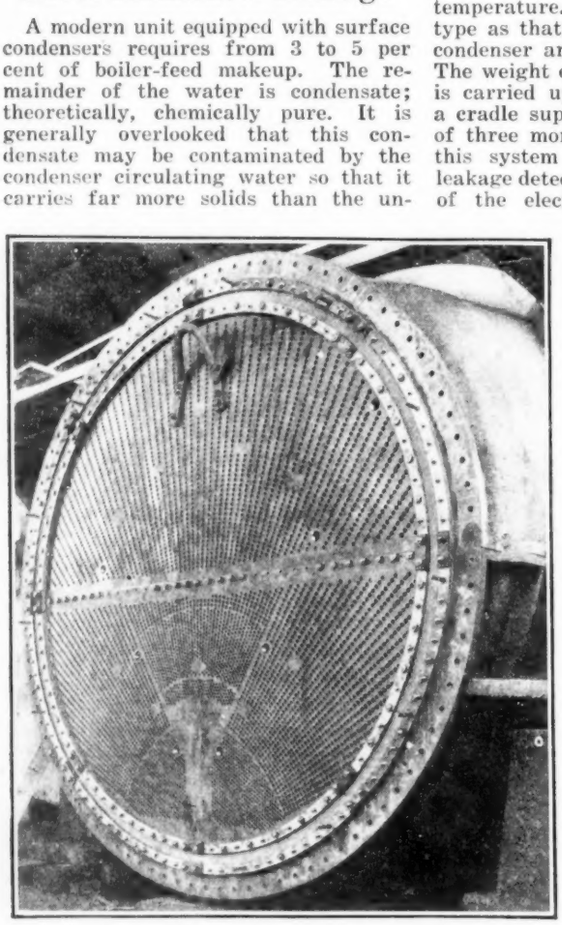
But the practice of blowing down boilers is apparently going out of date now that we have devices through which the blowoff water can be passed and the impurities removed, the water returning again to the boiler without any appreciable loss of heat. Naturally, they result in a considerable saving. M. M. GOOCH.

Atlantic Highlands, N. J.

New and Improved Equipment

Floating Condenser Tube Sheet Eliminates Leakage

A modern unit equipped with surface condensers requires from 3 to 5 per cent of boiler-feed makeup. The remainder of the water is condensate; theoretically, chemically pure. It is generally overlooked that this condensate may be contaminated by the condenser circulating water so that it carries far more solids than the untreated makeup water would contain.



Floating tube sheet with expansion joint

In the 1922 Report of the Prime Movers Committee of the N.E.L.A. on "Condensing Equipment," condenser leakage up to 2 per cent of the condensate was reported. One-half per cent leakage or over occurred in a large number of the cases tabulated. These condensers were all installed in large central stations where presumably every effort was made to keep the leakage at as low a point as possible. One-half of one per cent of sea water containing 2,200 grains per gallon total solids, is equivalent to 25 per cent makeup water containing 44 grains per gallon, a condition that would be tolerated in no modern power station.

To prevent this condition a special construction of condenser, built by the Wheeler Condenser & Engineering Co., has been employed in several plants using sea water as circulating water. The tubes are expanded in both tube sheets. One of the sheets is fixed in the usual manner, while the other is carried upon a rubber expansion joint in order to take care of changes in temperature. This joint is of the same type as that used between turbine and condenser and is practically leakproof. The weight of the tube sheet and tubes is carried upon two brackets forming a cradle support. Tests over a period of three months at a station in which this system is used, have shown no leakage detectable with a leakage meter of the electrolytic conductance type.

Condensers with one tube sheet floated upon an expansion joint are not novel. Earlier designs, however, were not satisfactory owing to difficulties from unequal expansion inherent in the condensers then in use. For satisfactory operation of an expansion joint such as this, all the tubes should expand and contract approximately the same amount; that is, at any moment they should all be at the same temperature. Uneven expansion would, perhaps, not be disastrous if all the cold tubes were at one side of the tube plate and all the warm tubes at the other, so that the plates might tilt, but if there are dead corners in the condenser with small groups of cold tubes surrounded by warmer ones, as is inevitable in the usual construction with a solid tube bank cut into by steam lanes, there is a tendency for the tubes to loosen in the sheet, due to the cold tubes holding the tube sheets together while the warm ones expand and loosen. For this reason a floating tube sheet could not be used until a condenser had been developed in which the tubes would be of uniform temperature.

In the condenser shown in the illustration, the tubes are arranged in rows tapering toward the air pump offtake so that the kinetic energy of the steam is utilized to secure even penetration and drive out the non-condensable gases. The temperature at the bottom of the condenser is within a fraction of a degree of that at the steam inlet. The steam inlet is offset toward the cold end of the tubes so that the steam is projected with the greatest velocity on these tubes.

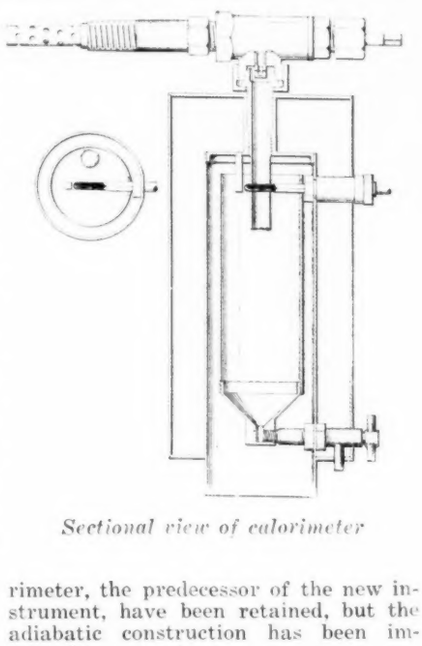
In the usual condenser with the steam inlet midway between the hot and cold ends of the condenser, the steam impinging upon the cold ends of the tubes is condensed before it can reach the bottom of the condenser, while the steam at the warm end penetrates to the bottom. The result is that the tubes in the bottom of the condenser being in contact with steam for only a part of their length near the warm end, are cooler than those in the top of the condenser. By offsetting the turbine exhaust toward the cold end, however, this is remedied and the tubes throughout the entire condenser are at the same temperature.

Temperature readings taken from tubes in different parts of a similar condenser show only a few degrees difference between the outlet temperature of the tubes at the very bottom of the condenser and the temperature of the water from the top tubes. The fact that there are no dead corners in this condenser is further attested by the coefficient of heat transfer, ranging from 750 to 850, approaching the theoretical value for a single tube condenser in pure steam.

External air coolers are used to devaporize the non-condensable gases before their removal by the air pump.

Ellison U-Path Steam Calorimeter

With the advent of higher steam temperatures and lower percentages of moisture, the more exacting technical requirements have brought forth the new Ellison U-Path steam calorimeter. The design features of the Ellison throttling-evaporating calorimeter, the predecessor of the new instrument, have been retained, but the adiabatic construction has been improved to promote accuracy.



Sectional view of calorimeter

Reference to the accompanying sectional drawing indicates that the new calorimeter combines throttling, separation and re-evaporation in a single

chamber. Steam entering the sample pipe flows at full pressure horizontally, with no up-turns to the throttling plug from which it passes through an orifice reducing to atmospheric pressure. Entering the steam chamber of the calorimeter, the throttled steam flows in a U-path, down one side and up the other, to escape at the top, where it turns and flows downward through a steam jacket and out at the bottom to atmosphere. A momentary abnormal moisture content, in excess of the throttling process, is separated in the chamber and is re-evaporated by the superheated steam after the period of excess, giving a true mean superheat temperature at the calorimeter thermometer.

To reduce calorimeter radiation, use is made of the three known methods—a steam jacket, an insulating jacket, and a bright exterior surface. The steam chamber is surrounded by a jacket of steam at the same temperature as the steam in the chamber, this being made possible by insulating the steam jacket against chilling with 1 in. of lampblack on the sides and 1½ in. on top of the steam jacket. The casing surrounding this insulation is composed of brass, highly polished and nickel plated.

An exhaust tube, 3x10 in., connecting telescopically with the steam jacket tube, is provided to carry away the escaping steam and to insulate the steam outlet against the possibility of chilling and a consequent lowering of the temperature.

With the thermometer packing cup located in the steam jacket, conduction of heat from the steam chamber through this source is eliminated. For the same reason the drain is located in the steam outlet.

To further minimize radiation loss, the valve was designed for compactness. With a seat and disk of monel metal, the valve is designed for a safe working pressure of not less than 1,000 lb. For opening and closing the valve, a socket wrench replaces the conventional handwheel. After being opened, the valve body and steam, union and steam-pipe nipple, are covered against radiation. Being on the chamber side of the throttling plug, the valve union is under atmospheric pressure and is not subject to leakage.

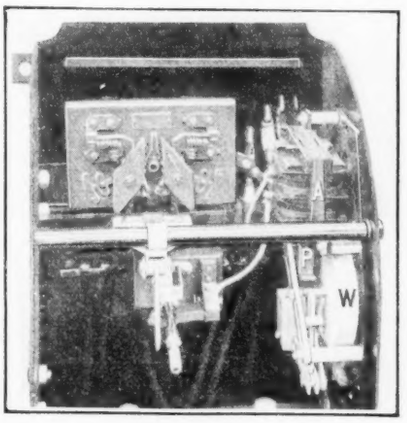
The dimensions of the instrument are: For the steam chamber, 2¼x6 in.; steam jacket, 3 in. outside diameter, and casing 5x10 in. The calorimeter is furnished in a birch carrying case 6x10x15 in., equipped with five throttling plugs of monel metal, interchangeable for the various pressures; one throttling plug wrench and one valve wrench; five sampling pipe tips, perforated in accordance with the A.S.M.E. code for 2,- 3,- 4,- 5- and 6-in. pipe; one ½-in. bronze pipe nipple, tapped at the ends for holding the interchangeable throttling tips; the 3x10-in. exhaust tube, and two gas-filled thermometers, reading up to 400 deg. F., in metal carrying cases to protect them from damage.

Lewis M. Ellison, 214 West Kinzie St., Chicago, is the manufacturer of the calorimeter.

Time-Delay Attachment for Hand Starting Compensators

A new time-delay attachment, announced by the General Electric Co., is designed for use with hand starting compensators to provide undervoltage protection during brief disturbances in industrial power circuits.

Many plants, utilizing a large number of motors, run separate circuits to



Time-delay attachment is shown at the right

energize the undervoltage coils of the starter, this circuit being furnished by a motor-generating running on its own momentum for some time after the failure of power. The new attachment was developed to meet the demand for a time-delay undervoltage release, resulting from the larger number of systems where there are momentary drops in the voltage; and the wider use of undervoltage protection on motor starters. It can readily be mounted on a hand starting compensator in the same supporting holes as used for the standard undervoltage release, as shown at *A* in the figure.

Time delay is accomplished by a falling solenoid plunger whose downward movement is retarded by a flywheel. A rack, which turns the flywheel *W* by means of a pinion on its shaft, is fastened to the solenoid plunger, *P*. On the downward movement of the plunger the flywheel is caused to revolve, but the parts are so designed that the upward movement of the plunger disengages the teeth of the rack from the pinion, permitting an instantaneous movement. The time delay is about 1½ sec., and if power returns in less than that time, the starting compensator is not tripped.

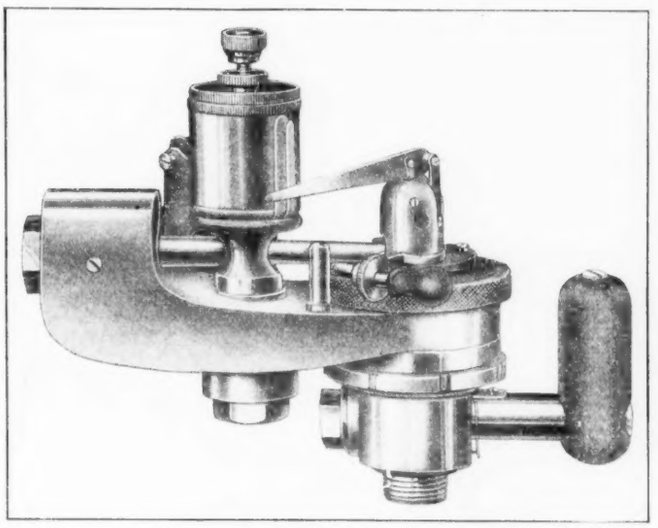
Engine Indicator for High Speeds and Pressures

The illustration shows an indicator of the Maihak type on which the American patent has recently been granted. The indicator is designed especially for use with high-speed internal-combustion engines, operating at speeds up to 2,200 r.p.m. and under pressures up to 1,400 lb. per square inch.

The principal feature of the indicator is the use of a cantilever spring in place of the usual helical type. The employment of this type of spring makes it possible to reduce the length of the piston rod to about one-quarter that used with indicators for slower speeds. The free end of the cantilever beam is shaped into a ball which fits into a socket in the piston rod.

An exceptionally short piston movement has been accomplished by using a straight-line motion with a multiplying ratio of one to eight, whereby sufficiently large vertical motion of the marking point is obtained with a short piston stroke. The frame of the instrument has been designed for maximum rigidity and to give a high period of vibration. The writing mechanism is of the usual five-joint construction.

A special drum detent and stroke reducing arrangement is provided for operating the indicator. The motion is made with an adjustable connecting rod, making it suitable for application to engines with different ratio of connecting rod to crank radius.



Indicator designed for high speeds and high pressures

The indicator is distributed by the Bacharach Industrial Instrument Co., 7000 Bennett St., Pittsburgh, Pa.

In an article in *Power*, Nov. 23, giving the operating costs of the Horton Kansas Municipal light plant, the statement was made that all three of the Diesel engines were of one make. This is incorrect as one of the units is a McIntosh & Seymour.

Regulations for the Installation of Pulverized Fuel Systems

PULVERIZED-FUEL systems are of various types; all involve the hazard incident to the creation and possible liberation of combustible dusts unless properly designed, constructed and operated. In general they may be arranged in three classes as follows:

Class A systems. Indirect or those in which the fuel is intimately mixed with air at the point or points where used and involving storage bins at points of consumption.

Class B systems. Direct or those in which the pulverized fuel is fed to a fan by which it is blown as a combustible mixture through large pipes to furnaces or other points of combustion. In the case of circulating systems of this class, the unused fuel is returned to the initial point to again be blown through the line. *In these systems the pulverizers are located remote from points of consumption.*

Unit Systems. Those in which the fuel is pulverized at or near the point or points of use and delivered directly from the pulverizer into the furnace by means of fan or blower, which may be an integral part of the apparatus, the air being admitted in the apparatus or in conjunction with the fuel. Systems of this type do not employ bins.

Installation of pulverized-fuel systems should be under the supervision of engineers qualified by experience in the design, construction and operation of such equipment.

These regulations are designed for application to new installations and when making alterations or extensions to existing equipment. They are not retroactive.

THESE regulations are sponsored by the National Fire Protection Association and include revisions adopted in 1925-26. Further revisions adopted by the subcommittee on "Fuel" but not as yet approved by the main committee on "Dust Explosion Hazards" are indicated by italics in the text. The extension of pulverized fuel during the last few years makes such regulations of concern to a rapidly increasing number of engineers. It has been requested that any criticisms or suggestions be forwarded to H. E. Newell, subcommittee chairman, 85 John St., New York, by Dec. 15.

General Regulations

Class A and Class B systems.

(See also specific requirements for Class A (Rules 17-20), Class B (Rules 21-26).

1. Location: (a) The process of pulverizing fuel shall preferably be accomplished in a separate detached building used for no other purpose.

(b) Where this is not feasible, this process shall be carried on in a separate room or separate floor used for no other purpose. This section shall be separated from the rest of the building by masonry walls and floors.

(c) Except for the passage of shafts, pipes and closed conveyors, these walls and floors shall, where practicable, be unpierced. Where feasible, all communication between the pulverizing plant and the rest of the building shall be from the outside or by means of fire-resistive stairways enclosed by masonry walls. In cases where this method of access to pulverizing plant is not feasible, indirect communication through separating walls by means of vestibules may be permitted, provided the wall opening is protected by a Class A automatic sliding firedoor and the vestibule opening by a self-closing hinged standard Class B firedoor at right angles to the sliding door or other suitably protected indirect communication approved by the Inspection Department having jurisdiction.

2. Construction: (a) The building containing pulverizing equipment shall be constructed of incombustible materials and specially designed (1) to secure minimum lodgment of dust: (2) so that all interior parts of the building on which dust may lodge may be cleaned readily: and (3) to relieve the force of an explosion through skylight, window or explosion doors.

(b) Depending on local conditions, either light or heavy type of building construction may be used for housing pulverizing equipment.

(c) A portion of the exterior walls and roof equal to not less than 10 per cent of the combined area of the enclosing walls shall be of light *non*-combustible material, preferably thin glass. *The arrangement shall be such that the maximum distance from any part of the room to the glass is not greater than 1.02 times the least horizontal dimension of the room; or, at least 50 per cent of the required glass area shall consist of windows approximately equally spaced on the long dimension of the room. When structural conditions prevent the close observance of this rule, a deviation of not over 10 per cent in dimension may be permitted.*

(d) Wired glass, if used, shall be in sash so hung that they will readily swing out in case of an explosion. Such sash shall not be secured; where thin glass is used this form of hanging is not necessary. Glass areas in walls shall be so located as to vent the force of any explosion in the direction or directions of least exposure.

Note: Wired glass should not be used unless necessary as protection against exposure.

(e) In buildings of light construction, the frame should be preferably of steel with light non-bearing walls (except fire walls) constructed of such materials as stucco on metal lath, metal or equivalent incombustible materials and with roof of monitor or gable type, and all secured in such a manner as to give way readily under pressure of explosion.

(f) In order to prevent accumulations of dust, the design of the buildings shall be such and the structural members so shaped and assembled or protected as to present the least possible extent of surface on which dust can lodge. Access must be provided for cleaning all parts of building on which dust may accumulate.

3. Ventilation and Dust Collection: (a) All buildings or parts of buildings in which the processes of pulverizing are carried on shall be well ventilated to the outer air.

(b) The atmosphere of the room shall be kept as free as possible from suspended or floating dust by maintaining all apparatus in a dust-tight condition.

(c) Static Dust. Good housekeeping is a factor of the utmost importance. To this end every coal drying and pulverizing plant shall be kept free from even small accumulations of coal dust. All interior surfaces shall be smooth and of a color, preferably white, which contrasts with the dust. They shall be cleaned at sufficiently frequent intervals to prevent accumulations of dust.

Interior surfaces shall be cleaned in such manner that no dust will be scattered or distributed. To this end it is recommended that dust removal be accomplished by an adequate pneumatic or vacuum sweeping system. The use of compressed air for blowing dust from motors or other equally inaccessible places is recommended, but the general use of compressed air (except in connection with water spray) for blowing dust from walls and other interior surfaces is prohibited.

(d) Because of the hazard attending the operation of motors and the use of flexible electric cable in coal pulverizing plants, the use of portable vacuum cleaners or air compressors is not recommended. Portable tanks containing compressed air may be used provided no electrical equipment is operated inside of the pulverizing room in connection therewith.

(e) Pneumatic sweeping systems, if installed, shall comply with the following general requirements:

1. Systems shall be of sufficient power and capacity to accomplish effective results.

2. Nozzles and handles shall be constructed of non-ferrous metal, fiber or other non-sparking material.

3. Hose, nozzles, handles and other metal parts shall be electrically grounded to the piping system and the piping system effectively grounded to the earth.

4. Dust separation shall take place before the dust reaches the exhauster. The separator or separators shall accomplish practically complete separation, as there should be no perceptible discharge of dust from the exhauster unless discharge is carried outside of the building. The dust entering the separator shall not directly strike a metallic surface.

5. The motor and separator should preferably be located outside of the pulverizing room.

4. Pulverizer: All pulverizer mills shall be safeguarded against the hazard of fire or explosion and be operated under competent supervision. Power for operation of pulverizing plant shall be controlled remotely at a readily accessible location and at the mill. Pulverizers, shafting and other metal parts of equipment and belts shall be electrically grounded in an effective manner.

5. Magnetic Separator: (a) A magnetic separator shall be provided for each system employing pulverizing mills *of other than Ball and Tube type. In each case the magnetic separator shall* be installed ahead of the pulverizer.

Every magnetic separator shall be safeguarded against the passage of coal over it when it is not magnetized, either by an interlock which will stop the flow of coal, or by a suitable alarm system which will notify the operator that the separator is not functioning.

Coal that has passed the magnetic separator shall be protected in such a manner as to prevent the entry of foreign materials.

(b) The magnetic separator shall be of such size as to expose and insure the removal of tramp iron or other magnetic substances.

6. Electricity for Light and Power: All electrical equipment for light and power in pulverizer house shall conform with the National Electrical Code. Provision shall be made for remote control in order that current for light and power may be cut off in an emergency without entering pulverizer house.

7. Dust Collectors: All dust collectors (except those of cloth type) shall be constructed throughout of non-combustible materials; cloth type collectors shall be provided with *dust* tight metal enclosures or their equivalent. The fabric of cloth type collectors shall be electrically grounded in an effective manner. All dust collectors used in connection with the pulverizing system unless located within the department *devoted to the pulverizing, drying or storing of coal, or in connection with transport systems on Class A bins, shall be located in separate rooms; dust collectors and rooms in which they are located shall be* properly vented to a safe point outside of the building.

8. Vents: Safety relief vents shall be liberally provided on all pulverizing equipments, particularly in the discharge *of the mill*, or in the case of air separating systems, at the top of the return duct to the mill; at elevator heads, at every storage bin for pulverized fuel and at dust collectors. Storage bin vents shall have a cross-sectional area sufficiently large to permit the separation of air from fuel without building up an abnormal pressure within the bin. Safety relief vents taken off pipes and flues shall be of at least the same area as the pipes or flues vented; they shall lead by the most direct practicable route to the outside air *in as nearly a vertical direction as practicable; they* shall not deviate more than 22½ deg. from the direction of the pipe or flue from which they lead, *provided that horizontal runs shall be avoided.*

Note: This rule does not apply to operating vents, meaning thereby such vents as may be required for efficient means of operation. Such vents may be connected into natural-draft boiler stacks or breechings to same, *or into an induced-draft suction near the fan*, provided they are equipped with automatic, balanced, non-corrodible dampers opening in the direction of the normal draft or with safety relief vents.

In no case shall operating vents be permitted to deliver into the open room.

9. Blowers, Handling Fuel in Suspension: (a) Blowers shall be installed on proper foundations and secured in a substantial manner. They shall not be used for any other purpose, but this shall not be construed as prohibiting the use of a blower as a means of supplying secondary air also.

(b) Bearings of blowers handling fuel in suspension shall not extend inside of blower castings or ducts.

(c) All connections between discharge end of blower and main duct shall be made so as to prevent leakage of fine dust. (See regulations for the Installation of Blower and Exhaust Systems.)

10. Driers: Driers may consist of three types, the direct and semi-indirect types, which are fired by special furnaces, and the indirect type, in which the coal is dried by means of inert gases from the boiler breechings, or by means of steam.

(a) Driers of the direct and semi-indirect types shall be so designed and constructed that the products of combustion of the heating unit shall not come in contact with the fuel being dried except at a distance of at least one-half of the length of the drier, and in no case within 12 feet of the fuel bed.

Such driers shall be designed to prevent gases of combustion from entering its shell when not in operation.

(b) Driers may be installed in boiler rooms of fire-resistive construction cut off in a standard manner from the rest of the plant. *When drier is located in a separate boiler house, construction of latter shall be of at least non-combustible material.*

(c) Direct and semi-indirect driers, if not located in boiler room as noted in 10(b) or in a separate building, shall be separated from the pulverizing department or any other section of the plant (except as noted under 10(b) or in similar occupancies) by means of non-combustible partitions or walls constructed of materials having a fire resistance of not less than one hour in accordance with standard specifications for fire tests of materials for construction.

Indirect driers, unless in a separate building or in boiler room, shall be similarly segregated, or be provided with a protective covering or insulation which will afford protection equivalent to materials capable of withstanding a one hour fire test as noted in the foregoing.

Note: See Rule 42(c).

(d) Coals (other than anthracite and coke): Drying coals (other than anthracite and coke) increases their tendency to spontaneous ignition. The quantity of dried coal, either unground or pulverized, stored in any plant, should be kept as small as possible without interfering with the continuity of plant operations. In all cases operating schedules shall be so arranged as to leave no dried unground coal in the plant when the mills are shut down for a period of four hours or more. In case all dried coal cannot be ground due to the mill being out of service for over four hours, all coal in the dried coal bins and driers shall be drawn out on the floor, and, if necessary, cooled before being fed to the mill.

The following table gives the maximum amounts, in hours supply, of pulverized coal which may be stored in connection with Class A systems, in any plant when reaching the mills at various temperatures. This recognizes the fact that the higher the temperature and the longer the time coal is in storage, the greater is its tendency to spontaneous ignition.

Temperature of Coal Entering Mills Deg. F.	Maximum Quantity of Pulverized Coal (Other than Anthracite and Coke) Which May Be Stored
250	4 hours' supply
225	8 hours' supply
200	12 hours' supply
175	16 hours' supply
150	18 hours' supply

Pulverized coal exceeding a temperature of 150 deg. F. shall not be stored in any bin in connection with a Class B system.

In order *to draw attention to* excessive rise in temperature of the coal in the driers, a temperature indicating and alarm device shall be installed in the discharge end of the drier with its sensitive member as close to the coal within the drier as practicable.

11. Dried coal elevator shall be of non-combustible construction dust-tight and provided with a safety relief vent to the outer air.

12. All pulverizing mills and driers shall be constructed as dust-tight as practicable and so operated as to avoid leakage of dust.

13. Pipe Lines: (a) All pipes connecting air mills, cyclones and mill bins should preferably be constructed of lap-welded steel pipe, seamless steel tubing, butt welded sheet steel or their equivalent. Where butt-welded sheet steel is used it should be No. 10 gage or thicker.

(b) Fittings shall be constructed either of cast iron or butt-welded sheet steel not less than No. 10 gage.

(c) Where cast-iron flanged fittings are used, the flanges shall conform to the 125 lb. American Standard in diameter, bolt circle and number of bolts.

(d) Where welded sheet-steel fittings are used, they shall be provided with removable wearing plates at all points subject to abrasion. When such plates are used, the size of the fittings should

be increased accordingly so as not to decrease their effective diameter.

(e) All joints shall be made either by means of standard pipe fittings or by *steel angle* flanges welded to pipes. *Where welded steel* flanges *are used, they* shall be not less than ¼-in. thick *held together by ¾-in. bolts, number of bolts to conform to the 125-lb. American Standard, center line of bolt holes to be not less than 1¼ inches from outside edge of flange. All pipe joints, control, switching and shutoff valves shall be of dust-tight construction.*

14. Storage and Furnace Bins: (a) Storage and furnace bins for pulverized fuel shall be located as far as consistent with operating requirements from furnaces, and away from open flames or open lights of any kind. *Bins* shall be *so located or constructed* that no radiation from furnaces, boilers, steam pipes or flues, or other heating appliances, can materially raise the temperature of the contents of the bin.

(b) All bins shall be of non-combustible material, so constructed as to present a smooth surface on the interior, and so shaped that no material will be left in the corners under normal emptying operation of the bin. Material used in construction of metal bins shall be of steel of sufficient thickness to secure ample mechanical strength. Joints shall be riveted and calked or welded; size and spacing of rivets shall be such as to secure a dust-tight joint. Dust-tightness shall also be secured in cases where metal bins are lined with concrete, or where bins are constructed of concrete.

(c) Except for vent openings, all storage and furnace bins shall be normally tightly closed. When bins are filled by transferring pulverized coal by means of air, either under pressure or by a fan, the arrangement should be such as to assure a minimum dust cloud within the bin. *If such vent openings permit entry of air into the bin, they* shall be equipped with tight-fitting dampers or checks.

(d) All bins shall be equipped with a reliable indicating device to warn the operator before the bin is in danger of overflowing without exposing the contents. At no time shall there be any pressure other than that caused by the weight of the fuel in any pulverized-fuel storage bin.

15. Ignition: For purposes of ignition or supplementary use, fuel oil, natural or artificial gas may be used if installed in an approved manner.

16. Fire Protection: Every building or room containing the foregoing processes shall be provided with approved fire extinguishers in such quantity and of such type as outlined in the regulations for the Installation, Maintenance and Use of First Aid Fire Appliances. Wherever the introduction of combustible material into the pulverizing room makes automatic sprinklers necessary for fire protection, their arrangement and control shall be approved by the inspection department having jurisdiction.

Indirect driers shall be provided with means of introducing live steam or inert gases by readily accessible, quick-acting valves.

Means should be provided to divert the contents of these driers to the outside of the building in case of emergency.

CLASS A SYSTEMS:

See also General Regulations (Par. 1-16).

17. Transportation Pipe Lines: All pipe lines for transporting pulverized coal between mill bins and points of consumption or storage shall be of standard full-weight steel pipe, and fittings equal to the 125-lb. American Standard.

18. Every coal conveying line shall be located away from all open flames or open lights of any kind, and at safe distance from sources of radiated heat, such as furnaces ovens boilers boiler settings, etc.

19. Screw Conveyors: Systems using screw conveyors for handling pulverized fuel shall be *normally* arranged with the driving power applied at the end toward which the fuel is being conveyed. Where the length of transfer is too great for a single screw so driven, any additional units shall be similarly driven and so interconnected that the stopping of the last screw in the series will automatically stop the others, or as an alternative for such interlocking the junction point between the two screw conveyors shall be placed outside of the building, and be provided with a normally closed spillway or relief valve.

When it is necessary to transport *fuel* in different directions and this is accomplished by the reversal of motors, the motors operating the screw conveyors shall be provided with overload releases and screw conveyor drives shall be provided with shearing pins. *All motors driving screw conveyors shall be provided with overload releases.*

20. (a) In no plant shall coal storage bins, conveying machinery or fuel pipe lines be used as supports for electric lighting or power lines other than those installed in conduit.

(b) Machinery and all other parts comprising the crushing, drying, pulverizing and conveying systems shall be electrically grounded in an effective manner.

CLASS B SYSTEMS:

See also General Regulations (Rules 1-16).

21. Piping: (a) *All piping, fittings, joints and flanges shall conform as to material, construction and installation with the requirements of Rule 13, General Regulations.*

(b) In each switch or branch line to burner, there shall be installed a suitable check which will be positive in operation.

22. Every coal-conveying line shall be located away from all open flames or open lights of any kind and at safe distance from sources of radiated heat, such as furnaces, ovens, boiler settings, etc.

23. Blowers: (a) Primary blower shall be operated and maintained at a rate producing a primary air pressure higher than that of the secondary or booster.

(b) Motor circuits for primary blower and booster fan shall be protected by the same circuit breaker, switch or other protective device, so that the stopping of either will cause the simultaneous stopping of the other.

24. All main circulating lines shall be free from baffles, valves or any obstruction which might cause an accumulation of pulverized fuel in the line.

25. Cyclone Separators: Cyclone separators shall not be placed directly over pulverized fuel storage bins, but shall discharge returned coal to the storage bin by means of gravity ducts, screw conveyor or other equally safe method.

26. (a) In no plant shall coal storage bins, conveying machinery or fuel pipe lines be used as a support for electric lighting or power lines other than those installed in conduits.

(b) Machinery and all other parts comprising the crushing, drying, pulverizing and conveying system shall be electrically grounded in an effective manner.

UNIT SYSTEMS

27. Pulverizer: The pulverizer shall be safeguarded against the hazard of fire or explosion, and be operated under competent supervision. Power for operation of pulverizer shall be controlled remotely at a readily accessible location and at the mill. The pulverizer, blower and all other metal parts of the equipment and belts shall be electrically grounded in an effective manner.

28. If heated air is admitted to the pulverizer, the heating shall be accomplished by an indirect method.

29. Magnetic Separator: (a) A magnetic separator shall be provided for each system *employing pulverizing mills of other than Ball and Tube type.* In cases where the coal is crushed before being conveyed to the pulverizer, the magnetic separator shall be installed between the crusher and the pulverizer.

(b) The magnetic separator shall be of such size as to expose and insure the removal of all tramp iron or other magnetic substances.

30. Electricity as Power for Operating: All motors, switches and other electrical devices in connection with equipment shall conform with the National Electrical Code.

31. Blower: (a) The blower shall be installed on proper foundation and secured in a substantial manner.

(b) Bearings of blower shall not extend inside the blower casing or ducts.

(c) All connections between discharge end of blower and main duct shall be so made as to prevent the leakage of fine dust.

32. All pulverizers shall be constructed as dust-tight as practicable and so operated as to avoid emission of dust.

33. No single apparatus shall supply more than two furnaces.

34. The volumetric capacity of the system, including the housing of mill, mixing chamber (if any) fan and all of the piping, shall not exceed 100 cu.ft. unless vented in accordance with the provisions of Section 8 of these regulations.

In cases where methods of venting required by this section and sections 40 and 41 are found impracticable, the intent of these requirements will be met if the pipe and fittings connecting the mill and burner or burners is designed for working pressure of 125 pounds.

Note: This construction will require compliance with the tentative American standard for Cast Iron Pipe and Fittings, or if steel is employed, compliance with the American Society for Testing Materials' standard specifications for standard weight welded and seamless steel pipe (Serial designation A53-24). Steel pipe larger than 12 in. in diameter shall be of a thickness not less than that required to withstand a test pressure of 450 lb. per sq.in., as included by the formula included in the aforesaid A.S.T.M. standard.

35. All portions of the system shall be confined within the room or section of building where the fuel is prepared or consumed.

36. Piping and fittings shall conform to the requirements of Section 13—Pipe Lines.

37. Each discharge pipe shall be provided with positive shutoff gate or control *installed immediately at point of junction with main discharge line.*

38. When two discharge pipes from separate pulverizers deliver to the same furnace through the same nozzle, a valve shall be provided at the junction of the discharge pipes which will automatically shut off the discharging pipe which is not in use.

39. Every vertical or nearly vertical pipe which delivers the fuel to the furnace through a down turn shall be provided with a safety relief vent, as provided for in Section 8 of these regulations.

40. No turn at an angle greater than 45 deg. shall be permitted in any pipe unless the pipe is vented as required in these regulations.

41. If a crusher, drier or other equipment is also used, installation shall be in accordance with the general requirements for Class A and Class B Systems.

Instruction Cards

42. An instruction card including the following precautions relating to safety operation shall be conspicuously posted in the pulverizing plant, boiler plant and in buildings where pulverized fuel is used.

(a) The crushing, drying and pulverizing plant should be under the supervision of a thoroughly competent and reliable foreman, and only competent and reliable workmen should be employed in connection with those operations.

(b) The use of shavings or other similar light combustible materials for starting fire in drier furnace is prohibited.

(c) The rotation of the drier shall not be stopped while it contains a charge of fuel.

Indirect driers delivering directly to the mills, shall be run empty before cutting out the mill, and coal gates, gas gates, or steam-heating valves shall be shut tightly. If it becomes necessary to shut down the mills for any reason for more than twenty-four hours, the driers should be emptied.

In cases of indirect drier fires, shut off coal inlet and outlet gates, gas inlet and outlet gates, and steam heating valves, if steam heated, and turn on steam gas extinguishing lines.

Note: When opening up a drier, transport line or other apparatus which has been sealed to extinguish a fire in the coal, or any place where live steam has been injected for the same purpose, precautions must be taken to prevent ignition of any gas which may have been generated during the period of the fire.

After the fire has been extinguished and the coal has been cooled below the ignition temperature, the drier should be ventilated with a vigorous current of fresh air for ten minutes or more to remove poisonous gases before persons are allowed to enter.

(d) Whenever a plant has been idle for a period of two days or more, all storage bins shall be thoroughly inspected before resuming operation.

(e) Manhole or inspection openings of furnace bins shall not be open while fuel is being discharged into the bins.

(f) Operators are cautioned against causing leaks in pipe lines or bins by hammering.

(g) Damper in drier chimney uptake shall be wide open when fire is started.

(h) In Class B Systems, if fuel supply line becomes clogged, the furnace shall be immediately cut off and the secondary air stopped. When obstruction has been cleared and before starting fan, a thorough examination shall be made to ensure the removal of smoldering particles of fuel.

(i) All fuel supply lines (of Class B and Unit System types) shall be blown clear of fuel when shutting down at close of day.

(j) All conveyors and elevators shall be tightly and securely inclosed and never opened while running. Previous to opening, machinery shall be stopped and dust allowed to settle for a period of 20 minutes.

(k) All stationary lights shall be protected with dustproof globes and wire guards. Only daylight or hand flashlights shall be used when inspecting the interior of coal storage bins and pulverizing and coal conveying apparatus when in operation. When apparatus is not in operation, guarded drop lights with dustproof globes utilizing superservice portable cord may be used. Special dustproof outlets and an adequate number of such cords shall be provided in every pulverizing plant. All conveying and distributing piping shall be inspected daily and any leaks promptly repaired.

(l) Smoking and the use of open lights or torches shall be prohibited in the crushing, drying and pulverizing plant.

Performance at the Langerbrugge Station*

High-Pressure Section, Employing Steam at 710 Lb. and 840 Deg., Shows 33 per Cent Saving Over Low-Pressure Section

THE high-pressure addition to the Langerbrugge Station, near Ghent, Belgium, described in *Power*, July 27, 1926, has now been in operation for over ten months, including 2,000 hours of day operation and one month of continuous day and night service. This addition to the station, it will be recalled, operates at 710 lb. pressure and 840 deg. F., at the turbine throttle. It consists of three high-pressure boilers, one 1,750-kw. high-pressure, and one 6,600-kw. low-pressure turbo-generator units. Air preheaters are employed, but no economizers are used. The high-pressure turbine is a cross-compound two-cylinder unit, operating at 8,000 r.p.m. on parallel shafts, and geared to a 2,000-kva. generator, operating at 1,500 r.p.m. Steam expands to 500 lb. in the first cylinder and to 285 lb. in the second. It then passes to the low-pressure cylinder at 626 deg., without reheat. Chain-grate stokers are used.

The following incidents or interruptions have been reported to date:

Trouble was had at the start with the feed pumps.

The generator of the high-pressure unit had to be overhauled.

These events were in no way chargeable to the exceptional steam conditions.

Explosion of superheater tubes occurred twice during the starting up period, but before the boiler had approached its rated pressure. This is supposed to have been due to the formation of air pockets in the superheater, and possibly to a too rapid firing rate at the start. The trouble has been entirely eliminated by circulating steam from an outside source through the superheater during the starting period.

The steam joints, valves and piping remained tight, but the steam drum and safety valves gave some trouble from leakage. The riveted drums may later be replaced by forged drums. The water gages were also a source of trouble, and several different types have been tried.

Accidental steam temperatures above 930 deg. F., and once above 1,000 deg. F., were observed, without apparent effect on the material used.

Results of tests from May 10 to May 15 last are contained in the accompanying table.

LANGERBRUGGE CENTRAL STATION OPERATING RESULTS, MAY 10 TO MAY 15, 1926

	May 10	May 11	May 12	May 14	May 15
Kw.-hr. produced	161,700	167,600	168,000	164,400	137,200
Kw.-hr. low-pressure	97,100	104,200	102,000	100,000	100,800
Kw.-hr. high-pressure	64,600	63,400	66,000	64,400	36,400
Pounds coal per kw.-hr.:					
Average	1.6	1.575	1.7	1.59	1.833
Low-pressure	1.85	1.895	1.895	1.813	1.927
High-pressure	1.18	1.196	1.19	1.247	1.256
B.t.u. per kw.-hr.:					
Average	20,000	19,900	19,970	20,080	21,900
Low-pressure	23,380	22,540	23,920	22,840	24,050
High-pressure	14,930	15,130	15,030	15,400	15,900
Saving, hp. over l.p.:					
In b.t.u. per kw.-hr.	8,450	7,410	8,890	7,440	8,150
In per cent of l.p.	36	33	37	32.5	33.8

May 13, 1926, being Ascension Day, no test data are available.

*From a report by M. L. Herry at the Convention of the International Union of Producers and Distributors of Electrical Energy, held in Rome, September, 1926.

High-Pressure Forged Drums To Be Covered by A. S. M. E. Code

THE existence of the extremely high-pressure boilers with forged drums and the probability that other such boilers will be constructed, has been recognized by the A.S.M.E. Boiler Code Committee in a proposed addition to the Boiler Construction Code. The following, which is quoted from a report of the Code Committee published in the November issue of *Mechanical Engineering*, will be of interest to readers who wish to keep in touch with the new developments in this field.

It is the policy of the Boiler Code Committee to receive and consider as promptly as possible any desired revision in the Rules in its Codes. Any suggestions for revisions or modifications that are approved by the Committee will be recommended for addenda to the Code, to be included later on in the proper place in the Boiler Construction Code.

Boiler Code Committee Asks for Comments

The Boiler Code Committee has recently received and acted upon a suggested new specification for hollow-forged seamless steel drum forgings which has been approved for publication as addenda to Section II of the Code. This specification is published below and is submitted for criticisms and comment thereon from anyone interested therein. Discussions should be mailed to C. W. Obert, Secretary to the Boiler Code Committee, 29 West 39th St., New York, N. Y., in order that they may be presented to the Boiler Code Committee for consideration.

After 30 days have elapsed following this publication, which will afford full opportunity for such criticism and comment upon the revisions as approved by the Committee, it is the intention of the Committee to present the modified rules as finally agreed upon to the Council of the Society for approval as an addition to the Boiler Construction Code. Upon approval by the Council, the revisions will be published in the form of addenda data sheets, distinctly colored pink, and offered for general distribution to those interested, and included in the mailings to subscribers to the Boiler Code interpretation data sheets.

Proposed Specifications for Hollow-Forged Seamless Steel Drum Forgings

1. *Process.* The steel shall be made by either or both the following processes: open-hearth or electric furnace.

2. *Discard.* Sufficient discard shall be made from the top and bottom of each ingot to secure soundness in the portion used for the drum forging.

3. *Forging.* The forging shall be made from a solid cast ingot, punched, bored, or hot trephined.

The resultant wall of ingot shall be reduced in thickness at least one-half by forging on mandrels.

4. *Chemical Composition.* The steel shall conform to the following requirements as to chemical composition:

	Class 1	Class 2
Carbon, maximum, per cent	0.35	0.45
Manganese, per cent	0.30-0.65	
Phosphorus, maximum, per cent		
{ Acid	0.04	
{ Basic	0.035	
Sulphur, maximum, per cent	0.04	

5. *Ladle Analyses.* An analysis of each melt of steel shall be made by the manufacturer to determine the percentage of the elements present. This analysis shall be made from a test ingot taken during the pouring of the melt. The chemical composition thus determined shall be reported to the purchaser or his representative and shall conform to the requirements specified in Par. 4.

6. *Check Analyses.* As a substitute for check analyses in the general rules, the purchaser may make an analysis from a broken tension-test specimen representing each drum forging. The chemical composition thus determined shall conform to the requirements specified in Par. 4.

7. *Heat Treatment.* Prior to taking test specimen, the whole of the forging shall be simultaneously annealed above its critical temperature. If additional forging is required after taking test specimens, the whole of the forging shall again be simultaneously reannealed above its critical temperature, but not above the temperature of the first anneal.

8. *Tension Tests.* The forging shall conform to the following requirements as to tensile properties:

	Class 1	Class 2
Tensile strength, min., lb. per sq.in.	60,000	75,000
Yield point, min., lb. per sq.in.	0.5 Tens. Str.	0.5 Tens. Str.
Elongation in 2 in., min., per cent	26	24
Reduction of area, min., per cent	42	38

9. *Bend Tests.* The test specimen shall withstand being bent cold through 180 deg. around a pin 1 in. in diameter, without cracking on the outside of the bent portion.

10. *Test Specimens.* *a.* Tension and bend-test specimens shall be taken from full-size prolongation of each forging after annealing, as provided for in Par. 7.

(*b*) One tension-test specimen shall be taken from each end of the forging. The axis of the specimens shall be located midway between the inner and outer surfaces of the wall parallel to the axis of the forging, the two specimens being taken from diagonal corners of an axial plane. Tension-test specimens shall conform to the dimensions shown[1] in Fig. 1. The ends shall be of a form to fit the holders of the testing machine in such a way that the load shall be axial.

(*c*) One bend-test specimen shall be taken from the end of the forging corresponding to the top of the ingot. The axis of the specimen shall be in a diametral plane perpendicular to the axis of the forging. The bend-test specimen shall be 1 in. by ½ in. in section, with edges rounded to $\frac{1}{16}$ in. radius.

11. *Number of Tests.* (a) Two tension tests and one bend test shall be made for each forging.

(*b*) If any test shows defective machining or develops flaws it may be discarded and another specimen substituted.

(*c*) If the percentage of elongation of any test specimen is less than that specified and any part of the fracture is more than ¾ in. from the center of the gage length, as indicated by scribe scratches marked on the specimen before testing, the specimen shall be discarded and another taken.

12. *Retests.* If the results of the physical tests of any forging do not conform to the requirements specified, the manufacturer may reanneal the forging and retests shall be made as specified.

13. *Permissible Variation.* The thickness of the parallel wall of each forging shall not be less than that specified. If the thickness of a portion of the wall of the forging is less than that specified, due to accidental or unavoidable irregularity of bore, the forgings may be accepted by the purchaser, provided such irregularity will not require lowering of the allowable working pressure below that for which the drum is designed.

The overweight limits are considered a matter of contract between the manufacturer and the purchaser.

14. *Finish.* The forging shall be free from injurious defects and shall have a workmanlike finish.

15. *Marking.* Each forging shall be legibly stamped by the manufacturer at each end with the name of the manufacturer, manufacturer's test identification number, and minimum tensile strength specified for the class of forging. The manufacturer's test identification number shall be legibly stamped on each test specimen.

[1]Fig. 1, not reproduced here, shows a cylindrical test piece with the central portion turned down to a uniform diameter of 0.505 in. This portion ends in fillets of radius not less than ½ in., the fillet centers being 2¼ in. apart. A 2-in. gage length is laid out for measuring elongation.

The expression "Hydrogen Ion Concentration" may some day be as familiar as "CO_2" is now. It denotes a method of stating numerically just how "acid" a solution is.

Recent Publications

Principles and Methods of Heat Saving. A report published by the National District Heating Association, 112 West Fourth St., Greenville, Ohio. Size, 6x9 in.; 43 pages. Price, $1 with large discounts in increasing quantities.

This pamphlet sets forth a joint report of the Research Committee of the National Association of Building Owners and Managers and the Heat Utilization Committee of the National District Heating Association. It discusses the heating and ventilation of buildings, particularly office buildings, and sets forth the principles whereby the comfort of the occupants can be insured with minimum expense, together with the description of practical means for putting these principles into effect.

This valuable pamphlet should be in the hands of every building superintendent and engineer who has a heating system under his control. It is prepared by a body of 48 men whose aggregate knowledge and experience in the heating field is immense, and their report is a mine of information of a variety that is unfortunately not common in technical literature. There is nothing mathematical or theoretical about the treatment; it simply tells in plain English how to apply good engineering common sense to the problem of saving money and increasing comfort in heating a building.

Accompanying this report is a four-page leaflet entitled "Office Ventilation," by W. E. Watt, of Chicago, which sells at $6 per 1,000 copies. It is designed to be distributed among the tenants of office buildings and sets forth a few sensible suggestions for the heating and ventilating of an office. Advice is given on the proper use of windows and transoms for keeping the air healthful and comfortable, and it is pointed out that the overheating of an office is distinctly objectionable from the new point of health as well as comfort. In many cases the uses of this pamphlet among tenants should prove helpful to the engineer and building superintendent whose efforts are naturally directed to good heat at low price.

Der Kreisrunde Uberfall und Sein Abarten. By Professor A. Staus and Professor K. V. Sanden. Published by R. Oldenbourg, Berlin, 1926. Paper; 6x9 in.; 39 pages; 16 illustrations; 4 tables.

With the increasing use of water for various purposes its accurate measurement becomes more important. In this little book the authors give the results of a series of investigations of measuring water with various forms of wiers. Tables and curves showing quantities and co-efficients for different forms of wiers are given. In all fifteen different shapes have been investigated. The treatment for the most part is highly mathematical and is intended for those interested in the theoretical side of the subject. Included is a bibliography of the literature on wier measurements, which adds to the value of the work. Copies of this book may also be obtained from A. Ott, Kempten, Allgäu, Germany.

Rotary and Motor Converters.—By Ernest F. Smith. Published by Crosby Lockwood & Son, Stationers' Hall Court, E. C. 4, London, England, 1926. Cloth; 5x7 in.; 57 illustrations; 233 pages. Price $1.80.

In this book the rotary converter has been presented in a way to interest operating engineers. First the principles of the direct-current generator and its operation under various conditions are dealt with. This is followed by a similar treatment of the alternating-current generator. These two machines have been discussed as a preparation for taking up the subject of the rotary converter, which may be looked upon as a combination of the direct-current and alternating-current generator.

One chapter has been devoted to the various characteristics of the converter, then methods of voltage control are discussed. Three chapters are given over to the different methods of starting and synchronizing. Parallel operation and protection is the subject of another chapter, as is also transformer connections. The book closes with one chapter on the motor converter, which consists of an induction motor combined with a direct-current generator. The motor has a phase-wound rotor which is interconnected with the armature winding of the direct-current machine. With the exception of a few vector diagrams the treatment is non-mathematical and the various subjects are presented in an easily read manner.

Elementary Mechanism. By Philip K. Slaymaker, professor of machine design, University of Nebraska. Published by D. Van Nostrand Co., New York, 1926. Size, 6x9 in.; 250 pages, illustrated.

This volume is intended for textbook use in the teaching of kinematics and covers the various methods for the transmission of motion with constant and variable velocity ratios, including the design of cams, gears, belt drives and linkages. The text is free from involved mathematical or graphical explanations and should prove useful not only for schools, but also for the individual draftsman desiring to learn something about the elements of this branch of mechanical engineering.

A. S. T. M. Tentative Standards, 1926. Published by the American Society for Testing Materials, 1315 Spruce St., Philadelphia, Pa. Paper 6x9 in.; 1,100 pages; Price, $7.50; cloth, $8.50.

The standards and the tentative standards of the A.S.T.M. are recognized as authoritative in the field of engineering materials, and this recent edition should prove valuable to engineers and other users of materials. A tentative standard, under the procedure of the A.S.T.M. is a proposed standard, which is published for one or more years with a view to developing experience and comment prior to its final adoption.

Sketches and Working of Oil Engines. By Julius Kuttner. Published by Motor Ship, New York City. Board backs; 10x13 in.; 86 pages; 164 illustrations. Price, $3.50.

Recently, so much has been published in book form concerning oil engines that bears evidence that the authors had little information to offer, that it is a relief to go over this volume by Julius Kuttner. While not being willing to agree with all the author's statements as to design and operation, the reviewer has found much in it of real value. The unfortunate error is made of devoting much space to the proving of a generally accepted theory, for example, the ways by which heat is absorbed from the piston. Although it is well known that in an uncooled piston the heat passes through the rings to the cylinder liner, the author has seen fit to discuss this at length. However, such points of criticism are but few, and the author is to be congratulated upon producing a volume that should be highly interesting to operators of oil engines.

Der Genauigkeitsgrad von Füguelmessungen bei Wasserkraftanlagen. By Prof. A. Staus. Published by Julius Springer, Berlin, 1926. Paper; 6x9 in.; 35 pages; 15 illustrations.

This book is published in German and deals with the accuracy of measuring water with current meters. Among the subjects discussed are: Selection of the site for gaging; determining the cross-section of the channel by different methods; current meters, methods of checking them, and factors that influence their accuracy; timing the meter by different methods; methods and procedure of velocity measurement; methods of computation; and degree of accuracy. The book closes with a bibliography of the literature on measuring water, which adds much to its value for those who are interested in this class of measurements.

Financial Limitations in the Employment of Forest Cover in Protecting Reservoirs, is the title of Bulletin No. 1430, recently issued by the United States Department of Agriculture. The bulletin was written by W. W. Ashe, assistant district forester, and can be obtained from the Superintendent of Documents, Government Printing Office, Washington, D. C., at 15c. per copy. Filling of storage reservoirs with silt in certain sections of the country is a serious problem. Reservoirs in some instances have been entirely filled, with the exception of the river channel. In this bulletin the author discusses erosion; the sections of the United States where it is most prevalent; the conditions of rainfall, surface and soil which cause excessive erosion; the means of reducing erosion for the protection of water-power resources; and the economic value of the protection from a financial viewpoint. The many angles from which the author discusses these subjects makes this publication of particular interest.

News in the Field of Power

Supreme Court Holds General Electric's Methods Legal

In a decision handed down by Chief Justice Taft, November 23, the United States Supreme Court sustained as legal the agency system for distribution of incandescent lamps of the General Electric Co. and declared valid and legal the license granted by this company to the Westinghouse Electric & Manufacturing Co. The effect of the decision is to hold legal the system by which the General Electric Co. controls the resale price of incandescent lamps.

The federal government brought suit against the General Electric Co., the Westinghouse Electric & Manufacturing Co., and the Westinghouse Lamp Co. in the northern district of Ohio, charging a violation of the Sherman Anti-Trust Law. The District Court dismissed the bill for want of equity and this decision is affirmed by the Supreme Court.

Monopoly System Charged

In its suit, the government charged that the defendant companies were evading a consent decree entered some years ago in a suit against the General Electric Co. and other corporations in which restraint of trade had been alleged.

It was charged under the later suit that the General Electric Co. had what tended to be a monopoly on the sale of incandescent lamps through its agency system and that it used such system to fix resale prices illegally. In the second place, it was charged that it was achieving the same purpose through control of licenses for the manufacture and distribution of such lamps by the other defendants.

The decision by the Supreme Court asserts that although the agents of the General Electric Co. distributing incandescent lamps are merchants, there can be no doubt that their relations to the corporation are those of agents of the company.

Insull Sees Big Electrical Gain for Chicago District

"Electric generating capacity available to the Chicago district is today more than 1,750,000 hp." declared Samuel Insull in an address to the Electric Association of Chicago at a meeting at the Hotel Drake, Nov. 19.

"This is comparable with the commercially available generating resources of the world's two largest electric districts; namely, the aggregate capacity of all electricity supply companies in the Greater New York district, and the aggregate Canadian and American capacity in the Niagara Falls district, including Buffalo.

"Additional generating capacity already ordered will raise the Chicago district total well above 1,500,000 kw. in a couple of years. A million and a half kilowatts is 2,000,000 horse power.

"The average selling price of electricity to the final user is lower in the Chicago district than it is in any other part of this country, with the exception of Niagara Falls, stated Mr. Insull.

Muscle Shoals Bill Looms As Congress' Early Problem

The Joint Congressional Committee on Muscle Shoals expects to meet during the first week of Congress to formulate plans for the handling of its bill.

The committee also will consider the adoption of a resolution assuring the Secretary of War that it has no objection to the consideration by the Federal Power Commission of applications for preliminary permits on the upper Tennessee.

Senator Deneen, of Illinois, the chairman of the Joint Committee, has stated his intention to press for early passage the bill recommended by the committee. This measure provides for the acceptance of the bid of the thirteen southern power companies.

South Unanimously in Favor

While it is certain that this bill will be used as a political football, many think it will be passed at this session. Members of Congress have been at home and have been taunted because of the inability of Congress to dispose of the Muscle Shoals matter. Some advocates of public ownership are anxious to see the matter settled as they recognize that the failure to dispose of this question constitutes a splendid example in favor of the contention that Congress cannot function effectively on business problems.

With the exception of Alabama the South is practically unanimous for the committee's bill. It is easy to understand why Alabama opposes the export of power. Many votes probably will be influenced by the attitude of the legislators from the section most concerned.

Florida Power Companies Linked in Merger

Consolidation of the Pinellas County Power Co., Florida Power Corp. and Central Florida Power Co. into a new company to be known as the Florida Power Corp. was announced, Nov. 25, by the Fitkin Public Utility interests.

The new company will serve a territory 300 miles long by 150 miles wide, from St. Petersburg north to the Georgia line. The West Florida Power Co. also will be included in the consolidation, it is stated.

D. H. Thomson, Former Head of Terry Turbine Co., Killed

Douglas H. Thomson, former president of the Terry Steam Turbine Co., of Hartford, Conn., was instaltly killed in an automobile accident on Prospect Hill, Warehouse Point, near Hartford, Conn., early in the night of Nov. 21.

Driving into Hartford with Mr. Thomson were Edward W. Cummins, of Winnetka, Ill., who also lost his life, and George S. Troxell, of Bridgeport, Conn., both of whom were classmates of Mr. Thomson's at Yale. Mr. Troxell was seriously injured.

Mr. Thomson was born in West Hartford, and was graduated from the Hartford High School and from the Sheffield Scientific School, Yale, in 1908. He came back to Hartford and entered the employ of the Terry Steam Turbine Co.

For nearly ten years he devoted his services to that concern, and became president toward the end of that association which terminated in 1918.

Active in Many Interests

Mr. Thomson was a member of the firm of Thomson, Fenn & Co., investment brokers with offices at No. 56 Pearl St., Hartford. The firm in its present form was organized in March, 1914. James L. Thomson and Hart C. Fenn were the founders of the business, many years ago.

It was upon the death of Mr. Fenn that Douglas H. Thomson, president of the Terry Steam Turbine Co., and a brother of James L. Thomson, became a member of the brokerage firm. In July, 1919, Mr. Gregory became a third member. He had just returned from the war.

Mr. Thomson was a director of the Farmington Water Co., the Sesamee Co., the Miller Co., of Meriden; Westwood, Inc., trustee of the Bankers Trust Co. and of the Society for Savings. He was also a member of the Hartford Club, the University Club of Hartford, the Hartford Golf Club, and the Yale Club of New York, and vice-president of the Farmington Country Club.

Hydro-Electric Service Soon for Pensacola

Hydro-electric power will be ready for distribution in Pensacola, Fla., by Jan. 1, according to estimates of engineers of the Alabama Power Co. who are rushing the work on the station just north of Pensacola, which is now nearing completion.

A central station will be erected as a sort of a sub-center station at some point between this city and Flomaton, thus helping convey current over a distance of forty-five miles between the city and Flomaton. This substation was ready for operation, according to schedule, Dec. 1.

Foshay Co. Buys Three More Utilities

Purchase of four public-utility companies in Illinois and Idaho was completed by the W. B. Foshay Co. of Minneapolis, Minn., and taken over by the Peoples Light & Power Co. recently.

Acquisition of the new properties brought the total communities served by the Peoples Light & Power Corp., which is controlled and managed by the W. B. Foshay Co., to 150 cities and towns in 10 states.

The new companies which will be linked with the Foshay group include the Freeport Water Co., of Freeport, Ill.; Wood River Power Co., serving Hailey, Bellevue, North Star, Gammett, Ketchum, Mines, Picabo, Carey, Richfield, Cascade and Fairfield, Idaho; Hailey Water Co. and the Adams County Light & Power Co., which serves Cambridge, Midvale and Counsel, Idaho.

The Freeport and Wood River companies were formerly properties of the Consumers Public Service Co. and were purchased from Baker, Walsh & Co., of Chicago, while the Adams Co. was purchased from a local Idaho concern.

The Peoples Utilities Illinois Corp. has been formed by the Peoples Light & Power Corp., to operate the Freeport properties, and the Idaho properties will be consolidated with the Peoples West Coast Hydro-Electric Corp., a subsidiary of Peoples Light & Power, which operates holdings in Washington and Oregon.

Hugh L. Cooper Attacks Lake Diversion As Wasteful

Diversion of Lake Michigan water by the Chicago Sanitary District is causing an annual loss to New England and near-by States of hydro-electric power worth $134,000,000, Colonel Hugh L. Cooper, electrical engineer, of Stamford, Conn., testified Dec. 1 before Charles E. Hughes, sitting as special master for the Supreme Court at the continuation of the hearing on Lake Michigan diversion.

The witness maintained that the diversion at Chicago was injuring navigation to the extent of $7,360,000 a year as a result of a lowering of the levels of the Great Lakes and the St. Lawrence River. New England alone had an annual ash pile waste of $35,000,000, he insisted, because it was deprived of its share of the St. Lawrence's hydro-electric potentialities, as were the entire State of New York and parts of Pennsylvania and Ohio. He estimated that withdrawal of 10,000 cubic feet of water per second at Chicago would represent an annual loss of 300,000 hp., or $9,000,000, at Niagara Falls.

Reports on St. Lawrence Up for Commission's Review

A meeting to consider the report of the international Joint Engineering Board on the St. Lawrence River development and the report made by the board of United States Army engineers on the proposed Lake to Hudson waterway will be held by the St. Lawrence River Commission of the United States meeting at Washington, Friday, Dec. 10.

Secretary Hoover is chairman of the commission. The other members are S. William C. Breed, New York; James P. Goodrich, Winchester. Ind.; James E. Davidson, Bay City, Mich.; Charles L. Allen, Worcester, Mass.; James R. Howard, Chicago, Ill.; James P. Noonan, Stephen B. Davis, and Charles P. Craig, all of Washington, D. C.

Bankers Eager To Take Over Operation of Great Falls

If the government will develop the Great Falls water power project, E. H. Rollins & Sons, New York investment bankers, are anxious to assume operation on a long-time contract.

This has been represented to Members of Congress by Clarence E. Martin, of Martinsburg, W. Va., attorney for the firm.

The concern is willing to take over operation immediately after government construction of the dams, erecting its own manufacturing plant. This will lower the government cost by $15,000,000, it is said. War Department experts have estimated it will take $45,000,000 to harness the falls.

Martin has strong support in Chairman Zihlman, of the House District Committee, who has introduced a bill which would accomplish the company's plan.

Senator Norris, of Nebraska, who got a bill through Congress two years ago providing for government development and operation, is still opposed to private operation. He believes the short session will not give either measure a chance.

Lease of Alabama Power Co. To Run Another Year

Secretary Davis of the War Department announced on Nov. 20 his approval of another twelve months extension of the lease of the Alabama Power Co. to the 60,000 kw. steam power plant No. 2 at Muscle Shoals, Alabama. The original lease for one year was executed in 1921 and it has been renewed annually since then.

A War Department statement said that even with hydro-electric power developed by the government plant on the Wilson dam at Muscle Shoals the output of the steam plant was needed to meet power demands in southern territory.

Up to Oct. 31 of this year, the government had received $1,114,584 from the lease of the steam plant to the power company.

National Body Scores High Rates Controlled by Few

Rates to domestic consumers of electricity have not been reduced in proportion to the increased revenues reported by public utilities in recent years, says a report issued to the public by the Committee on Coal and Giant Power, a body formed more than a year ago as a national group of economists, lawyers, engineers, labor leaders and business men.

The complete report consists of four parts. Part I deals with the concentration of power control in New York State; Part II, the State control of the St. Lawrence power; Part III, the adequacy of the New York system of regulation and the conflict between state and federal regulatory bodies. Part IV, which concludes the report, will be issued before Jan. 1.

The report states that the power industry of the country is capitalized at about $8,000,000,000 and that 66 per cent of the industry is controlled by thirteen groups operating chiefly in New York State. It says in part:

"The concentration of control in the hands of a few companies is supposed to result in economies and efficiencies which will be reflected in the rates charged to the consumers. In the six years from 1920 to 1925 the power industry as a whole reports an increase in production of 50.6 per cent, an increase in gross revenues of 66 per cent, and a decrease in operating ratio of 21 per cent. Yet during this period average retail lighting rates have gone down only five mills, one-half cent, which is a decrease of 6.25 per cent from their 1920 level.

Lists 558 Rates

"In New York State the Public Service Commission lists 558 maximum retail lighting rates for about 550 communities throughout the State. Of these 462 were listed in a similar form in 1920 and so furnish a basis of comparison for rate changes during the six-year period. Of these 256, or 55.5 per cent, were the same as in 1920; 17, or 3.6 per cent, were higher; 189, or 40.9 per cent, were decreased. The decreases varied in size. Some were considerable; others, barely noticeable. Lack of weighting on the base of population served by each rate makes these figures valuable as an indication only of the rate changes throughout the State. The two-cent drop in the Buffalo maximum rate, for example, would, under proper weighting, count as much as fifty larger decreases in various small townships.

The committee reports that the power companies have done "a land office business in acquiring each other." In this connection it says:

"They have built for themselves a series of superimposed holding companies which not only gather the profits of the operating companies in a less conspicuous manner, but raise a series of problems for both investors in their stock and for the consumers of light and power. Their existence has changed the face of the regulatory question confronting the Public Service Commission. The adequacy of its present power to protect the public is now seriously questioned."

The membership of the committee at present is: Engineers, Champlain Riley, A. B. Jones, H. C. Cross; economists, Stuart Chase, Prof. Robert L. Hale, Prof. A. B. Holcombe, George Soule, Donald Richberg and Delos Wilcox; lawyers, Arthur Garfield Hays, Morris Ernst, J. H. Ryckman and Senator George W. Norris; business men, Milton Jones and J. H. McGill; labor, Edward Wieck, C. J. Golden and Oscar Ammeringer; publicists, Robert Bruere, McAlister Coleman, Miss Evelyn Preston and Norman Thomas.

Liquid Fuels Chosen Topic for M.I.T. Symposium

Leading authorities of the country on the subject of liquid fuels for internal-combustion engines will be the speakers at both meetings of a symposium on gasoline to be held the afternoon and evening of Jan. 15 at the Massachusetts Institute of Technology, under the auspices of the Northeastern Section of the American Chemical Society.

At the afternoon session Dr. W. K. Lewis, head of the Department of Chemical Engineering at the Massachusetts Institute of Technology and consultant for some of the larger oil companies, will speak on "Petroleum Resources and the Influence of New Refining Methods on the Supply of Gasoline." He will be followed by Dr. A. C. Fieldner, chief chemist of the U. S. Bureau of Mines, whose subject is to be "Motor Fuels from Coal."

A demonstration of methods for the measurement of knocking is scheduled for the evening. Dr. Graham Edgar, technical director of the Ethyl Gasoline Corp., will talk on "Anti-Knock Fuels and Knock Suppressors." T. A. Boyd, in charge of the fuel section, General Motors Corp., will then speak on "The Use of Gasoline in Automobile Engines."

Seattle Launches $24,000,000 Power Plant Preliminary

Contemplating the expenditure of $24,000,000 in the development of another great hydro-electric plant on the Skagit River, in Skagit County, by the City of Seattle, Wash., application was made Nov. 7 for appropriation of 3,300 cu.ft. of water per sec. from the Skagit River and all its tributaries above Ruby Canyon, in Skagit and Whatcom counties.

A fall of 500 ft. will be utilized in the development of 140,000 hp. of electrical energy. Estimated cost of the power plant proper is $16,000,000, while another $8,000,000 is estimated for the great Ruby reservoir, which is to impound 3,800,000 acre-feet, submerging an area of 17,000 acres. It is estimated the project will be completed in 1933.

The application in behalf of the City of Seattle was signed by J. D. Blackwell, city engineer, and J. D. Ross, superintendent of lighting.

McGraw Electric Co. Unites Several Western Utilities

The McGraw Electric Co. has been formed under the laws of Delaware to consolidate public utility properties formerly operated by the Platte Valley Power & Light Co. and the Central West Public Service Co. and their subsidiaries and other independent utilities.

The properties serve 129 cities and towns in Iowa, Nebraska, Minnesota, South and North Dakota. The new company also has acquired the electrical supply and engineering construction businesses formerly owned by the McGraw company at Sioux City and Omaha.

Idaho Power Development Adds Two More Units

According to H. L. Singer, chief engineer for the Idaho Power Co., improvements calling for expenditures of over a million dollars will be made at the power plant of American Falls, Idaho.

Two 6,000-kw. units will be installed, and the local plant will be the largest in the Idaho system, giving a production capacity of 17,000 kw. Though it has been announced that work will begin on the improvements at once, it is expected that they will not be completed before next fall.

Prof. Pupin Urges Place for History as Leading Science

Establishment of a division of History in the National Academy of Sciences is urged by Prof. Michael I. Pupin, of Columbia University, internationally famous for his discoveries in electricity. Professor Pupin is a past-president of the American Institute of Electrical Engineers, and a member of the American Engineering Council.

History is our most important science, declares Professor Pupin, author of "From Immigrant to Inventor," in a statement issued through the American Historical Association. He is a member of the New York City Committee, headed by Charles E. Hughes, which is aiding the Association in its nation-wide campaign for a $1,000,000 research endowment.

Professor Pupin asserts that in determining whether history or anything else is a science he applies the test of "three M's."

"It is a matter of some surprise to me that many persons do not consider history a science," Professor Pupin says. "In my opinion this is a very narrow view of the meaning of the term science. I would describe science as an activity which is guided by a definite motive, a definite mental attitude and a definite method of work.

"The motive of the scientific worker must be an unselfish search for the truth. His mental attitude must be an open-mindedness which is free of all prejudice. His method of work must be the method which in the hands of men like Archimedes, Galileo, Newton, Faraday and the great historians, has conferred so many blessings on mankind.

"Historical research which is not guided by such a motive, such a mental attitude and such a method of work, cannot lead to great results. But if it is guided by these three 'M's' then it is a science."

Personal Mention

C. J. McCabe has been appointed chief smoke inspector for the City of Detroit, following a competitive civil-service examination in which Mr. McCabe achieved the first place. Mr. McCabe held the same post for Detroit under the former laws, which were superseded some months ago.

T. R. Fluker is now manager for the Ware County Light & Power Co., and has taken up his duties at Waycross, Ga.

Charles A. Stanwick, mechanical engineer, is now associated with Day & Zimmerman, engineers, 1600 Walnut St., Philadelphia, Pa.

H. A. Neil has been promoted to division superintendent for construction work and installations in Ware and adjoining counties of Georgia by the General Engineering & Management Corp.

George C. Fisher, power-plant engineer of Philadelphia, has accepted the post of smoke inspector for Nashville, Tenn. Mr. Fisher assumes his duties as the eighth member of the smoke abatement commission. He was recently with the operating department of the Philadelphia Electric Co.

Reuben B. Sleight, who has been the engineer of the Minnesota Tax Commission since 1922, has accepted a position as assistant to Commerce Secretary Hoover. He will do research work on subjects pertaining to the electrical industry, succeeding Paul S. Clapp, who resigned recently to become secretary of the N.E.L.A.

Business Notes

The Electric Controller & Manufacturing Co. of Cleveland, Ohio, announces the appointment of Farr Electric Service Inc., 228 W. South Temple, Salt Lake City, Utah, as its representative.

The "Flexitallic" Gasket Co., manufacturing the flexible asbestos-metal gasket, Camden, N. J., has established a branch office at 539 Singer Building, New York City. Frank Groves, sales manager of the company, is in personal charge of the office.

The Chuse Engine & Manufacturing Co., Mattoon, Ill., has elected George A. Hepke, of Hamilton, Ohio, vice-president of the company and also has selected him as general sales manager. Mr. Hepke was formerly sales manager of Hooven, Owens & Rentschler Co., of Hamilton, Ohio.

The Wickes Boiler Co. announces the removal of its Detroit district sales offices from the Penobscot Building to the General Motors Building, Jan. 1; also that Henry E. Aldrich has been promoted to the position of general manager with headquarters at Saginaw, Mich. Having resigned as district sales manager for the Heine Boiler Co., J. Robert Fortune is now general sales manager for the company.

The Power Economy Specialty Co., in the field of power plant engineering service, was recently organized with headquarters at 604 Fox Bldg., Philadelphia, Pa., by W. J. Kyle for the purpose of acting as sales agents for manufacturers of plant equipment. The company is handling sales for the Marion Machine Foundry & Supply

Co., of Marion, Ind., manufacturers of stokers, soot blowers, water heaters and coal crushers, and also represents the Burt Manufacturing Co. of Akron, Ohio, for oil filters and roof ventilators.

The Westinghouse Electric & Manufacturing Co. has recently appointed as stoker specialist in the New York district W. C. Strunk, who has been in charge of stoker negotiation work at the South Philadelphia works of the company. Mr. Strunk, a member of the A.S.M.E., succeeds in his present duties E. R. Stone, recently promoted to manager of stoker sales.

Trade Catalogs

Mechanical Rubber Goods — The Pioneer Rubber Mills, San Francisco, Calif., recently issued Catalog No. 20, which lists the principal lines of rubber transmission belting, conveyor and elevator belting, and packing.

Raw Water Ice Making Systems and Supplies — Jos. A. Martocello & Co., Philadelphia, manufacturers of clear ice-making equipment and supplies have issued for 1927 an elaborate Catalog No. 51 on Martocello systems.

Lubrication for IXL Speed Reducers —The Foote Bros. Gear & Machine Co., Chicago, Ill., has put out a bulletin for the successful lubrication of spur gear, herringbone, and worm-gear speed reducers. Each of these IXL types is considered as to construction and installation before the oiling systems are taken up.

Silent Gears—The General Electric Co., Schenectady, N. Y., has issued a well illustrated catalog on Fabroil and Textolite silent gears. The manufacture, characteristics of the material and the finished products, together with application data with reference to duty, are fully treated. Recommended practice for machining the gears is also dealt with.

Welding Rods—The Chicago Steel & Wire Co., 103rd St. & Torrence Ave., Chicago, manufacturer of "Weldite" welding rods, has just issued two booklets, one on the "Properties of Steel Filler Rods for Gas and Electric Welding," and the other on the "Effect of Surface Materials on Steel Welding Rods." Both contain a substantial amount of technical information.

"Hytempite in the Power Plant"—The Quigley Furnace Specialties Co., 26 Cortlandt St., New York City.—This bulletin illustrates and describes some of the applications of Hytempite in refractory construction and maintenance. The use of crushed old firebrick for patching and rebuilding furnace walls, making monolithic baffles and special tile, is described and illustrated, giving tables of the correct mixtures together with methods of application. How the Quigley Refractory Gun is used for applying plastic refractory materials is covered in considerable detail on pages 19 to 21.

Automatic Arc Welding—The Lincoln Electric Co., Cleveland, Ohio, has just issued a booklet, "Automatic Arc Welding with Lincoln 'Stable-Arc' Automatics." The construction of these machines and their application to the manufacture of welded tanks, pipe-line sections, etc., are explained.

Nickel Steel—The International Nickel Co., 67 Wall St., New York City. To meet the need for authoritative information on nickel steel the company has compiled in convenient form and is now distributing, a series of technical bulletins. Of this series the following eight are issued in the present binder: No. 1, "Society of Automotive Engineers Standard Specifications for Steels"; No. 2, "Physical and Mechanical Properties of Nickel Steels"; No. 3, "Heat Treatment and Applications of Nickel and Nickel Chromium Steels"; No. 4, "Making Steel Castings Stronger"; No. 5, "The Mill Inspection of Steel"; No. 6, "Alloy Steel Reduces Die Block Costs"; No. 7, "Automobile Design and Automotive Steels," and No. 8, "Improving Gray Cast Iron with Nickel."

Hydrogen Ion Control—The LaMotte Chemical Products Co., Baltimore, Md., has just issued what might be described as a combination textbook and catalog under the title, "The ABC of Hydrogen-Ion Control." Following a remarkably clear and practical exposition of the meaning and measurement of hydrogen-ion concentration, its application to various industrial processes is shown. These include water purification and softening. The catalog section lists color standards, comparators of the "block" and "roulette" forms, and related test sets.

Coming Conventions

American Association for the Advancement of Science. Annual meeting at Philadelphia, Dec. 27-Jan. 1; Burton Livingston, Secretary, Smithsonian Institution Bldg., Washington, D. C.

American Engineering Council. Annual meeting at Washington, D. C., Jan. 13-15. L. W. Wallace, 24 Jackson Place, Washington, D. C.

American Institute of Electrical Engineers. Winter convention at New York City, Feb. 7-10; F. L. Hutchinson, secretary, 33 West 39th St., New York City.

American Society of Heating and Ventilating Engineers. Annual meeting at St. Louis, Mo., Jan. 25-28; A. V. Hutchinson, secretary, 29 West 39th St., New York City.

American Society of Mechanical Engineers. Annual meeting to be held at Engineering Societies Bldg., 29 West 39th St., New York City, Dec. 6-9. Dr. Calvin W. Rice, secretary.

American Society Refrigerating Engineers. Annual meeting will be held at Hotel Astor, New York City, Dec. 6-8. Wm. H. Ross, secretary.

Chicago Power Show, at Chicago, Feb. 15-19. G. E. Pfisterer, managing director, 53 West Jackson Blvd., Chicago.

Engineering Institute of Canada. Richard John Durley, secretary, 176 Mansfield St., Montreal, Que. The forty-first annual general and general professional meeting will be held at Montreal on Thursday, Jan. 27, and will be adjourned to reconvene at Quebec City at the Chateau Frontenac Hotel Feb. 15, continuing on the two succeeding days.

National Association of Stationary Engineers. New England States convention at Portland, Me., June 17-18. Thomas H. Clark, president, Worcester, Mass.; Robert Johnson, secretary, 65 Charlotte St., Worcester, Mass.

National Electric Light Association. A. Jackson Marshall, secretary, 29 West 39th St., New York City. Annual convention at Atlantic City, week beginning June 6.

National Exposition of Power and Mechanical Engineering. Fifth Annual Exposition at Grand Central Palace, New York City, Dec. 6-11.

National Marine Engineers' Beneficial Association. Fifty-third annual convention at Washington, D. C., Feb. 14. Albert L. Jones, secretary-treasurer.

Fuel Prices

COAL

The following table shows the trend of the spot steam market in various coals, f.o.b. mines; mine run except Pittsburgh gas slack:

Bituminous Net Tons	Market Quoting	Nov. 29 1926
Pool 1	New York	$3.75@$4.25
Smokeless	Boston	4.00
Clearfield	Boston	2.50@ 3.00
Somerset	Boston	2.75@ 3.25
Kanawha	Columbus	2.25@ 2.75
Hocking	Columbus	2.00@ 2.50
Pittsburgh	Pittsburgh	2.35@ 2.50
Pittsburgh gas slack	Pittsburgh	2.00@ 2.10
Franklin, Ill.	Chicago	2.75@ 3.00
Central, Ill.	Chicago	2.50@ 2.75
Ind. 4th Vein	Chicago	2.50@ 2.75
West Ky.	Louisville	1.25@ 2.00
S. E. Ky.	Louisville	2.10@ 2.75
Big Seam	Birmingham	2.00@ 2.25
Anthracite Gross Tons		
Buckwheat No. 1.	New York	2.25@ 3.50
Buckwheat No. 1.	Philadelphia	2.40@ 3.00
Birdseye	New York	1.25@ 2.00

FUEL OIL

New York—Dec. 2, light oil, tank-car lots; 28@34 deg. Baumé, 5¾c. per gal.; 36@40 deg., 6¼c. per gal. f.o.b. Bayonne, N. J.

St. Louis—Nov. 23, tank-car lots, f.o.b. St. Louis; 24@26 deg., $2.05 per bbl.; 26@28 deg., $2.10 per bbl.; 28@30 deg., $2.15 per bbl.; 30@32 deg., $2.20 per bbl.; 32@36 deg., gas oil, 6c. per gal.; 38@40 deg., 7½c. per gal.

Pittsburgh—Nov. 23, f.o.b. local refinery; 30@34 deg., fuel oil, 6½c. per gal.; 36@40 deg., fuel oil, 6¾c. per gal.

Philadelphia—Dec. 1, 27@30 deg., $2.52@$2.58 per bbl.; 13@19 deg., $1.725@$1.785 per bbl.

Cincinnati — Nov. 29, tank-car lots f.o.b. local refinery, 24@26 deg. Baumé, 6½c. per gal.; 26@30 deg., 6⅝c. per gal.; 30@32 deg., 7c. per gal.

Chicago—Nov. 6, tank-car lots f.o.b. Oklahoma, freight to Chicago, 92c. per bbl.; 24@26 deg., $1.35 per bbl.; 26@30 deg., $1.45; 30@32 deg., $1.65.

Boston—Nov. 29, tank-car lots f.o.b. 12@14 deg. Baumé, 4.8c. per gal.; 28@32 deg., 6c. per gal.

Dallas—Nov. 9, f.o.b. local refinery, 26@30 deg., $1.70 per bbl.

New Plant Construction

Ark., Searcy—City will soon receive bids for waterworks improvements including distribution system, pumping equipment, etc. Estimated cost $80,000. Dickinson & White, 608 Boyle Bldg., Little Rock, are engineers.

Ark., Springdale—City plans extensions and improvements to waterworks including pumping station, etc.

Calif., Alhambra—City, T. B. Downer, Supt., plans waterworks improvements including 1,000,000 gal. reservoir, deep well turbine pump, booster pump, etc.

Calif., Los Angeles—City had plans prepared for the construction of a sewage pumping plant on Mar Vista Ave.

Calif., San Francisco—Edgewater Beach Club, c/o Walker & Eisen, Great Republic Bldg., Los Angeles, is having plans prepared for the construction of a hotel and club building on Great Highway. here. Estimated cost $1,150,000.

Conn., Stamford—City will receive bids until Dec. 13 for the construction of a sewage pumping station. Fuller & McClintock, 170 Broadway, New York, N. Y., are engineers. J. C. Williams, is city engineer.

Fla., Jacksonville—City voted $2,000,000 bonds for electric light and power requirements including large sub-station, transmission lines, etc. Scofield Engineering Co., c/o Commercial Trust Bldg., Philadelphia, Pa., is engineer.

Ga., Cordele — Crisp County is having plans prepared for the construction of a 20,000 hp. hydro-electric plant on Flint River. Estimated cost $1,250,000. E. S. Killebrew, Albany, Mo., is engineer.

Ill., Chicago—M. K. Wolf, c/o H. Dalsey, 64 West Randolph St., Archt., is having plans prepared for the construction of a 14 story hotel at North Dearborn and Division Sts. Estimated cost $1,000,000. Electric refrigeration system will probably be installed.

Kan., Salina—City, C. E. Banker, Clk., will receive bids until Dec. 14 for the construction of a sewage treatment plant and pumping station including pumps, etc. Haskins & Crawford, 822 Finance Bldg., Kansas City, Mo., are engineers.

La., Bastrop—Bastrop Ice & Cold Storage Co., W. L. Hood, Mgr., is having preliminary plans prepared for the construction of addition to ice plant. Private plans.

La., Franklin — City will receive bids about Dec. 15 for a 400 to 500 hp. Diesel oil engine and generator set and switchboard equipment, also addition to power house. H. A. Mentz, Hammond, is engineer.

Me., Caribou—Atlantic Public Utilities Inc., C. W. Young, Pres., 70 State St., Boston, awarded contract for the construction of a hydro-electric plant here to Ring Construction Co., Caribou, Me.

Mass., Amesbury—Merrimack Hat Corp., 60 Merrimack St., is receiving bids for the construction of a boiler house. Estimated cost $40,000. F. W. Dean, 141 Milk St., Boston, is engineer.

Mass., Lynn — Commission of Ways & Drainage, awarded contracts for the construction of a sewage pumping station to Tunnell Construction Corp., 709 Sixth Ave., New York, N. Y., and W. T. Dimeen Construction Co., Security Trust Bldg., Lynn, Mass. Estimated cost $185,140 and $123,716 respectively.

Mich., Detroit—Providence Hospital, 2500 West Grand Blvd., plans the construction of a 4 story nurses' home including steam heating boiler and equipment, etc. on Wabash Ave. Estimated cost $750,000. Weston & Ellington, Stroh Bldg., are architects.

Minn., Minneapolis—Intersection Holding Co., M. T. Baker, Pres., Baker Bldg., is having plans prepared for the construction of a 12 story office building including steam heating system, elevators, etc. at Seventh St. and Marquette Ave. Estimated cost $900,000. Larson & McLaren, 308 Baker Bldg., are architects.

Mo., Lees Summit — Unity School of Christianity, 917 Tracy St., Kansas City, is having plans prepared for the construction of a group of school buildings including central heating plant, etc. Estimated cost $1,500,000. E. Boillot, 1202 Scarritt Bldg., Kansas City, is architect.

N. J., Atlantic City—M. Ellis, 419 Arch St., Philadelphia, Pa., plans the construction of a 19 story hotel at Boston Ave. and Boardwalk here. L. J. Brook 65 Madison Ave., New York, N. Y., is architect.

N. Y., New York—Park Ave. and Thirty Third St. Corp., 65 West 39th St., A. N. Adelsohn, Pres., awarded contract for the construction of a 25 story office, loft and stores building to Schroeder & Koppel, 347 Madison Ave. Estimated cost $4,000,000. Ten electric elevators will be installed.

N. Y., New York—J. G. Siegel Inc., 343 Madison Ave., will build a 16 story apartment on West 86th St. Estimated cost $800,000. Architect not selected. Work will be done by separate contracts.

N. Y., New York—P. Weinstein, 303 Greenwich St., will build a 6 story apartment at Walton Ave. and 157th St. Estimated cost $1,000,000. Work will be done by separate contracts under the supervision of Glick & Duma, 400 East Fordham Rd., Archts.

N. Y., New York—The Alexander Wilson Co., 180 Madison Ave., will soon receive bids for the construction of an 18 story office building including 4 electric elevators at 274 Madison Ave. Estimated cost $650,000. Sloan & Robertson, 441 Lexington Ave., are engineers.

N. C., Mount Airy—W. C. Sydnor, Mayor and Bd. of Commissioners, will receive bids until Dec. 14 for waterworks improvements including pumping station, filter plant, reservoir, motor driven centrifugal pump and accessories, tank on tower, etc. G. C. White & Co., Durham, are engineers.

N. C., Newton—City plans improvements to waterworks including intake dam, pump house, centrifugal pumps, power transmission line, etc. Spoon, Lewis & Camp, 704 Flatiron Bldg., Asheville, are consulting engineers.

O., Shaker Heights (mail Cleveland)—Laurel School for Girls, c/o S. E. Lyman, 1971 East 97th St., Cleveland, is receiving bids for the construction of a group of school buildings including steam heating plant here. Estimated cost $500,000. J. H. Graham & Co., 1612 Euclid Ave., Cleveland, are architects.

Okla., Anadarko — City voted $40,000 bonds for the installation of a 400 hp. Diesel engine and generator in light plant. H. E. Musson & Co., Grain Exchange Bldg., Oklahoma City, are engineers.

Okla., Shawnee—City voted $586,500 bonds for the construction of a new waterworks system including wells, pumps, motors, etc. E. T. Archer & Co., 609 New England Bldg., Kansas City, Mo., are engineers.

Pa., Philadelphia—A. L. Erlanger, C. D. Dillingham & Stanley Co. of America, 1916 Race St., are having sketches made for the construction of a 14 story theatre and stores building at 21st and Market Sts. Estimated cost $1,500,000. Hoffman-Henon Co., Finance Bldg., is architect.

Pa., Pittsburgh—Aiken Apartment Corp., 606 Commonwealth Bldg., awarded contract for the construction of a 9 story apartment at Center and Aiken Aves. to C. F. Kramer, 411 Meade St. Estimated cost $1,000,000.

Tenn., Crossville—City voted $100,000 bonds for the construction of a complete waterworks system including wells, pumps, tank on tower, etc. Engineer not selected.

Tex., Amarillo—Badger Ice Co., will soon receive bids for the construction of a 150 ton ice and refrigeration plant. Estimated cost $250,000. Engineer not selected.

Tex., Denton—Water & Light Dept., H. T. Brewster, Supt., plans to purchase and install a 250 to 400 hp. engine and generator for waterworks. Estimated cost $20,000. Private plans.

Tex., Laredo—A. C. Richter & Associates, will soon award contract for the construction of a 10 story hotel including refrigeration system, elevators, etc. Estimated cost $500,000. Kelwood Co., Travis Bldg., San Antonio, is architect and engineer.

Tex., Lubbock—The Peoples Ice Co., c/o G. T. Scales, awarded contract for improvements to ice plant to increase the capacity to 40 ton daily to Frick Co., Waynesboro, Pa. Estimated cost $15,000.

Tex., Midland—Morgan Utilities Inc., A.O.U.W. Bldg., Little Rock, Ark., has been granted franchise to construct an ice plant, 110 ton capacity, probably electrically driven here. Estimated cost $200,000. Private plans.

Tex., San Anegelo—San Angelo Water, Light & Power Co., affiliated with and operated by the West Texas Utilities Co., Abeline, plans the construction of a power plant on Lake Concho near here. Estimated cost $831,000 Sargent & Lundy, 72 West Adams St., Chicago, Ill., are engineers.

Tex., San Antonio—Santa Rosa Infirmary, 745 West Houston St., plans the construction of addition to hospital including steam heating system, 2 elevators, etc. Estimated cost $500,000. L. M. J. Dielmann, 306 East Commerce St., is architect.

Tex., San Saba—American Fertilizer & Chemical Works, c/o T. F. Hawkins, is having plans prepared for the construction of a plant for the manufacture of hydrated lime and calcium arsenate for agricultural purposes. Estimated cost $150,000. Private plans. The plant will be operated with electric power, equipment will be required.

Tex., Waco—O. H. Cross, is having plans prepared for the construction of a 12 story hotel including steam heating system at Fifth and Franklin Sts. Estimated cost $700,000. Lang & Witchell, 300 American Exchange Bank Bldg., Dallas, are architects.

Tex., Waxahachie—Supreme Ice Cream Co., G. W. Ledwell, Pres., is receiving bids for the construction of an ice cream plant including the installation of a refrigeration plant. Estimated cost $30,000. Private plans.

Wis., Cameron—Cameron Creamery & Product Co., G. Speirs, Pres., plans the construction of addition to creamery. Estimated cost $100,000. Architect not selected. Refrigeration machinery will be required.

Ont., Toronto—Elliot Bros., Elliot House, is having plans prepared for the construction of a 12 story hotel including steam heating system, elevators etc. at Shuter and Church Sts. Estimated cost $500,000. William F. Sparling Co., Metropolitan Bldg., is architect.

Ont., Toronto—J. T. Ransom, Metropolitan Bldg., will build a 4 story apartment including steam or hot water heating and refrigeration systems at Yonge St. and Farnham Ave. Estimated cost $500,000. Work will be done by separate contracts.

Ont., Toronto—St. Michaels Hospital, Victoria St., awarded contract for masonry, steel work, etc. for a 7 story hospital on Victoria St. Estimated cost $500,000. Steam heating and ventilation systems, elevators, etc. will be installed.

Ont., Toronto—Western Hospital, 391 Bathurst St., plans the construction of a 4 or 5 story hospital including steam heating and ventilation systems, etc. Estimated cost $1,000,000. E. J. Lennox, 364 Bay St., is architect.

Ont., Walkerville—Essex Border Utilities Commission, R. B. Braid, Secy., Murray Bldg., Windsor, will soon award contract for the construction of a 3 story hospital including steam power plant, ventilation system, etc. here. Estimated cost $500,000. Pennington & Boyde, Bartlett Bldg., Windsor, are architects. Stevens & Lee, 62 Charles St. E., are associate architects.

Que., Montreal—Canada Sugar Refineries Ltd., 511 St. Catherine St. W., awarded contract for the construction of a power house to John MacGregor Ltd., 121 Bishop St. Estimated cost $100,000.

Que., Montreal—Cutten & Foster, 696 Dorchester St. W., is in the market for two 10 hp. electric motors.

Que., St. Alban — Shawingan Water & Power Co., 83 Craig St. W., Montreal, plans the construction of a 4,000 hp. hydro electric development on Ste Anne River here. Estimated cost $600,000. Power house equipment will be required.

N. Z., Wellington—New Zealand Government Railways, will receive bids until Jan. 17 for switchgear, armoured cables, junction boxes, motor generator sets, etc. for Hillside Locomotive workshops, also until Jan. 31 for new car and wagon workshops at Otahuhu.